

SCIENCE

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Kodak reports to laboratories on:

some information we hope you'll use and some we hope you won't... how to carve a fancy design on a microscopic bit of semi-conductor

Data for the times

As a kind of a public service, we feel we ought to print the following table:

KODAK FILM	Kodak Developer	Time (min.)	1,000-KVP X-rays— Roentgens for density of		
			0.3 net	1.0 gross	2.0 gross
1. Kodak Royal Pan Film	DK-60a	4	1.2	13.2	440
2. Eastman Plus-X Panchromatic Negative Film	D-76	8	3.7	19	450
3. Kodak Commercial Film	DK-50	5	4.3	47	305
4. Kodak Contrast Process Panchromatic Film	D-11	5	11.5	36	98
5. Kodak Infrared Aerographic Film	D-19	9.6	1.2	4.0	18
6. Kodak Linagraph Ortho Film	D-19	7	1.1	3.2	12
7. Kodak Super-XX Aerographic Film	D-19	9.6	1.2	3.8	17
8. Kodalith Ortho Film, Type 2	Kodalith	2.25	—	1400	1700
9. Recordak Micro-Film Panchromatic Film	Kodagraph	5	90	220	560

We have three reasons for printing it, in decreasing order of importance.

1) In the event of nuclear disaster, pieces of film that survive lighttight might serve as fortuitous dosimeters. Few American population centers of 10,000 souls or more wouldn't contain at least a box or two of such a popular product as *Kodak Royal Pan Film*. Giving it the above-indicated processing normally recommended for that film would provide a radiological survey party with a quick and rough estimate of the amount of prompt radiation that hit where the film was stored. The table neglects the possibility of solarization, but perhaps this is an excessively lugubrious thought.

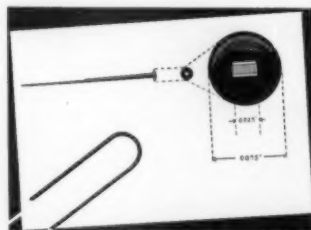
2) In these nuclear times, the question often arises of how much radiation it takes to spoil film for its intended purpose. Here is a guide to tolerance judgments, since the sensitivity of a particular photographic material is essentially the same for all radiations harder than 1,000-kvp x-rays.

3) It's an excuse to tick off a few film names you might like to know about. No. 2 is one of the main threads for Hollywood's loom of glamour and glory. No. 3 is sheet film with good tone rendition for monochrome subjects, slow enough for processing by inspection under a relatively bright Series 1 Safelight. No. 4 is the basic sheet film for black-and-white photomicrography. No. 5 has sensitivity out to nearly

10,000Å and comes in widths up to 9½" and lengths up to 390 feet. No. 6 is 16mm and 35mm film for recording repetitive patterns from green-emitting c-r tubes, unaffected by reddish cathode glow. No. 7 is the world's No. 1 film for aerial photography. No. 8 is a sheet film that gives either inky blackness or diaphanous clarity and nothing much between. And No. 9 provides 16mm or 35mm sanctuary for records by the billions.

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Saw out a blank of the semi-conductor crystal. Lap and polish it, finishing up with 0.5μ grid-size diamond paste. Etch off the remaining few microns of work-strained layer. Wash in trichloroethylene, rinse in distilled water, and dry.

Avoiding daylight or ultraviolet, filter a little *Kodak Photo Resist*. With it, coat the polished semi-conductor surface thinly. Dry under a heat lamp. Hold the stencil tight against the semi-conductor by vacuum. Expose to an arc lamp. Immerse in *Kodak Photo Resist Developer*. Take out. Put on a few drops of *Kodak Photo Resist Dye* to make the developed image visible. Hold under a stream of tepid distilled water to wash away the resist where the dark portions of the stencil shielded it. Pull up the window shades. Blot off the surface moisture. Inspect the pattern with a microscope. If OK, bake for a few minutes to harden the resist. Let an etchant suitable to the specific semi-conductor remove it to any required depth in those areas where there is no resist left to resist.

Over the whole, deposit a metal electrically, chemically, or by evaporation. Immerse in 2-Ethoxyethyl Acetate* for 10 minutes and gently swab. This solvent, undeterred by the overlying metal film, removes the remaining resist.

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This is basically Bell Telephone Laboratories' idea; not ours. All we did was to suggest Kodak Photo Resist. Apparently it was a good suggestion. Anybody else who wants any suggestions about the Kodak products involved can write Eastman Kodak Company, Graphic Reproduction Division, Rochester 4, N. Y.

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The State Department's Opportunity in Science

Five years ago the Department of State appointed a science adviser in Washington and a small number of scientists to serve as attachés in the United States embassies in several western European capitals. The positions still exist, but every one is now vacant. The science adviser left 2½ years ago, and the last science attaché came home a few weeks ago. No effort is being made to recruit successors.

Yet the program had a good start and was growing in value. The men who served as science attachés were recognized scientists. Probably most of them did not remain long enough to attain full effectiveness, although fairly rapid turnover was expected. Even so, reports of their accomplishments apparently convinced the Bureau of the Budget and the Congress that the positions should be continued, and money was appropriated for this purpose in every year since the positions were established. We understand that the range of work in the science adviser's office—which still exists even though there is no science adviser—has widened and that the volume has increased.

Responsibility for the present situation lies in the Department of State itself. Officers of the department have been considering whether the system should be continued and the form and auspices under which it could work most effectively. One possibility is to transfer the science attachés to the Central Intelligence Agency. This was the recommendation of the Hoover Commission. Transfer of science attachés to that agency would mean a complete shift of function to straight intelligence collection and away from advisory services in the conduct of foreign relations. In sharp contrast with many excellent recommendations of the Hoover Commission, this one seems to us to be completely wrong and probably to arise from a misrepresentation of the attachés' functions.

As originally planned, the science attachés were expected to facilitate the flow of scientific information, to serve as official scientific representatives of the United States, and to advise the Department of State and the embassies on matters that affect foreign relations. While the facilitation of the flow of information may appeal to many scientists as the most important of these responsibilities, the main function has been advisory.

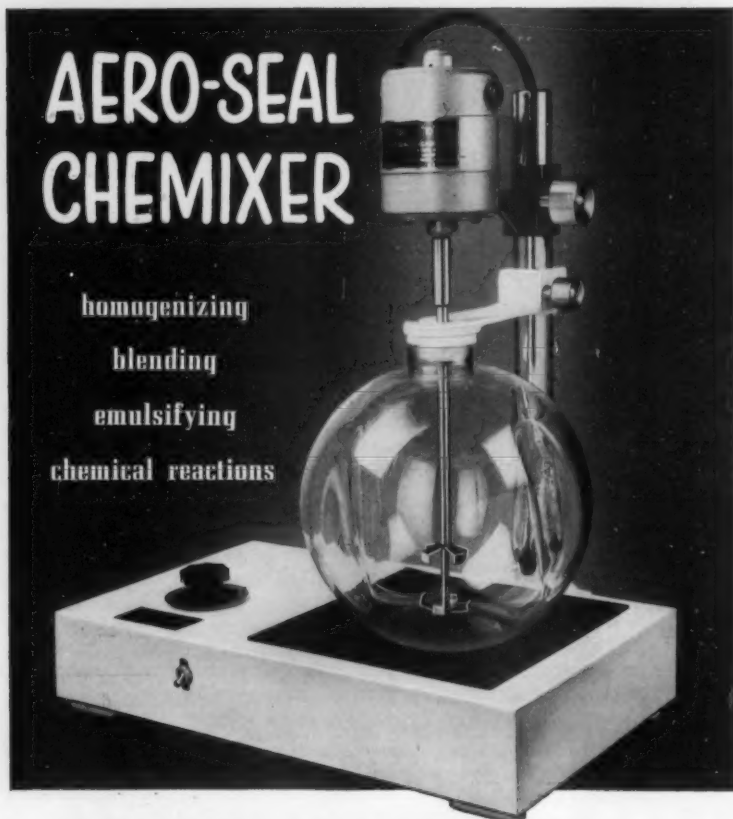
In today's world, foreign affairs are multifaceted. Questions concerning public health, sanitation, natural resources, atomic energy, aviation, engineering, or other scientific and technologic matters are involved in many of the decisions concerning treaties, international organizations, and other international arrangements. Scientific information is only one of the bases for making policy decisions, but those decisions can be better made if all of the relevant information is considered than if one important area is neglected. Whenever scientific and technologic elements are significant for foreign relations, they should be brought to the attention of the embassies and the Department of State and be weighed with political, economic, and other relevant factors.

By failing to appoint a science adviser and science attachés, the Department of State is depriving itself—and the country it represents—of one of its authorized assets.—D. W.

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Magnetic Moment of the Electron

P. Kusch

I must say, and with considerable regret, that I am not a theoretical physicist. A penetrating analysis of the part that the discovery and measurement of the anomalous magnetic moment of the electron has played in the development of certain aspects of contemporary theoretical physics must be left to the group of men who have in recent years devised the theoretical structure of quantum electrodynamics. My role has been that of an experimental physicist who, by observation and measurement of the properties and operation of the physical world, supplies the data that may lead to the formulation of conceptual structures. The consistency of the consequences of a conceptual structure with the data of physical experiment determines the validity of that structure as a description of the physical universe.

Our early predecessors observed nature as it was displayed to them. As knowledge of the world increased, however, it was not sufficient to observe only the most apparent aspects of nature to discover its more subtle properties; rather, it was necessary to interrogate nature and often to compel nature, by various devices, to yield an answer concerning its functioning. It is precisely the role of the experimental physicist to arrange devices and procedures that will provide information that will enable us to make quantitative statements concerning the properties and behavior of nature. It is in this spirit that I will discuss here my participation

in a sequence of earlier experiments that made possible the precision determination of the magnetic moment of the electron. I will then discuss the experiments themselves—the experiments that have yielded our present knowledge of the magnetic properties of the electron.

Atomic and Molecular Beams

Research with atomic and molecular beams has had a long and fruitful record in the history of the growth of our present knowledge of matter. The experiments that I shall discuss are some in which the method of atomic and molecular beams is used essentially as a spectroscopic device for the observation of spectral lines in the range of frequencies within which power may be generated by electronic means. The general principles of radio-frequency spectroscopy by the method of molecular beams were first described by Rabi and a group of his coworkers (1) of which I was fortunate to be a member. It is here sufficient to say that a transition between energy levels may be observed through the circumstance that the magnetic moment of an atom or molecule may be changed in a transition. The method is characterized by a very high-potential resolution; in many observations of the frequency of a line, an accuracy of better than 1 part in 1 million has been achieved. It is of particular value as a tool in the investigation of the details of interactions within atoms and molecules because small interactions appear as first-order effects rather than as small superpositions on the relatively enormous energies that characterize optical spectra.

Electron Properties

The fact that the electron has a spin of $\frac{1}{2}$ and a magnetic moment at least approximately equal to 1 Bohr magneton has long been recognized. Uhlenbeck and Goudsmit first postulated these properties of the electron to explain the fine structure in atomic spectra and what has been called the anomalous Zeeman effect (2). An enormous body of evidence has given ever-increasing support to these postulates. The relativistic Dirac theory of the electron assumed a particle that was endowed with the properties of mass and charge. The spin and magnetic moment postulated by Uhlenbeck and Goudsmit were then found to be a consequence of the relativistic invariance of the Dirac equation. Indeed, one of the great triumphs of the Dirac electron theory was the prediction of these postulated electron properties. The spin and moment of the electron were thus removed from the realm of *ad hoc* assumptions, justified by experimental evidence, to the realm of an integral part of quantum theory. The Dirac electron theory did not, however, consider the interaction of the quantized electromagnetic field with the electron.

I shall talk of the measurement of the g value rather than the magnetic moment of the electron. The g value is, as usual, the negative ratio of the magnetic moment in terms of the Bohr magneton μ_B and the angular momentum in units of $\hbar/2\pi$. Since, in all cases here under discussion, the angular momentum of the system is known, the moment can immediately be obtained from the g value. The most elementary of the g values, g_L , is that associated with the orbital motion of the electron. Its value is 1 within small and calculable corrections. The electron also has a magnetic moment by virtue of its angular momentum about a spin axis. The g value associated with the spin, g_S , is the quantity here under investigation; a value of 2 was obtained for it in the Dirac electron theory. Now the electrons in an atom have both spin and orbital angular momentum. To the total electronic angular momentum J , we assign the g value g_J . The atom contains a nucleus that may have a nuclear angular momentum and hence a nuclear magnetic moment. The nuclear g value, g_N , is designated as g_P in the special case when

Dr. Kusch is professor of physics at Columbia University. This article is based on a lecture that he gave when he was awarded the Nobel prize in physics for 1955, a prize that he shared with Willis E. Lamb. It is published here with the permission of the Nobel Foundation. Dr. Lamb's lecture will appear in a subsequent issue.

the nucleus is a proton. To the total angular momentum of the atom we assign the g value g_F .

Early Measurements

The earliest measurements by the molecular-beams magnetic resonance method were undertaken by a group, of which I was a member, that worked in Rabi's laboratory and under his direction (1). The measurements consisted of the determination of nuclear g values by the observation in a molecule of the nuclear resonance frequency in a classically determined magnetic field. Even in the great national laboratories dedicated to the maintenance of physical standards, a precision of only about 1 part in 40,000 has been achieved in the measurement of a field (3). In a well-equipped laboratory that lacks the equipment and tradition of meticulous intercomparison of electric standards, a precision of perhaps $\frac{1}{4}$ percent may be achieved in the determination of the magnitude of a field. While ratios of nuclear g values may be found without an explicit knowledge of the field, the accuracy of the determination of a nuclear moment in terms of the Bohr or nuclear magneton is limited by the uncertainty in the measurement of a field as well as by the uncertainties in a prior measurement of the Bohr or nuclear magneton. Thus, the desirability of a direct measurement of a nuclear g value in terms of the Bohr magneton is apparent.

The molecular-beam magnetic resonance method was originally applied to the determination of the nuclear g values in molecules that did not have a net electronic orbital or spin angular momentum. It is, however, possible to apply the same experimental techniques to an investigation of the hyperfine structure of atoms. If we observe transitions between the various F levels at zero or very low magnetic field, the hyperfine structure separation may readily be found. At a higher magnetic field, the observation of the frequency of transition between magnetic sublevels yields again the zero-field hyperfine structure splitting, the quantity $g_I\mu_0 H/h$, and the quantity g_N/g_I , although the latter quantity can be found with only limited precision. The group of which I was a member at Columbia made the first such studies on the commonly occurring isotopes of the alkali atoms and determined the magnetic hyperfine structure interaction constants of the alkali atoms (4). Extensive subsequent work in the observation of atomic hyperfine structure has, of course, been done in many laboratories with results of great interest in the study of higher order moments in nuclei and of the properties of radioactive nuclei. The alkali atoms were particularly adaptable to the

original experimental work first because the beams of the atoms may readily be produced and detected and second because they occur in $^2S_{1/2}$ states, almost wholly free of perturbation by other states.

The possibility of measuring the moment of a nucleus in terms of the Bohr magneton is a consequence of the possibility of observing both nuclear resonance in molecules with a frequency $g_N\mu_0 H/h$ and transitions among the magnetic components of hyperfine structure levels for which the dependence of frequency on field is of the order of $g_I\mu_0 H/h$. Millman and I then addressed ourselves to the problem of measuring the moment of the proton in terms of the electron spin moment (5). The experimental problems were considerable and arose from three factors.

The first of these was related to the fact that the effective moment of a molecule of zero electronic angular momentum is of the order of a nuclear magneton while that of an atom is of the order of a Bohr magneton. Deflecting fields that allow the observation of a change in trajectory of a molecule in which a hydrogen nucleus has undergone a transition will deflect an atom through unmanageably large excursions if the field is arbitrary. However, all atoms in which magnetic hyperfine structure occurs and in which the spin of the nucleus is greater than $\frac{1}{2}$ have, in certain states, zero magnetic moments at definite values of the magnetic field, which may be very high. Atoms in such states may thus traverse a carefully adjusted inhomogeneous field without catastrophic deflections; and a transition from such a state may at once be detected because the terminal state is generally characterized by a large magnetic moment. Thus, it is possible to choose the deflecting field in such a way that a change in the spin orientation of a nucleus in a molecule and a transition among the magnetic levels of the hyperfine structure may both be detected.

The second of our experimental problems was related to the production of a beam of molecules that contained hydrogen and, simultaneously, an alkali atom, which was requisite for the detection of beams by the techniques then available to us. Since atomic lines were to be observed at the same field as nuclear resonance lines, the simultaneous production of a beam of alkali atoms was necessary. We used beams of sodium and potassium hydroxides evaporated from silver ovens and noted that, at the temperatures required to generate a beam of the hydroxide, the reaction between an alkali halide and metallic calcium proceeded at such a rate that a convenient beam of atoms appeared.

The third experimental problem was associated with the need of applying to the same circuit, in succession, two fre-

quencies that differed by as much as a factor of 70 and with the prewar difficulty of generating sufficient power at high radio frequencies.

Extensive intercomparison of the frequencies of the resonance line of the proton and of lines in the hyperfine structure spectra of sodium, rubidium, and cesium—for each of which a prior determination of the interaction constants had been made—led to a determination of the ratio of the proton moment and the spin magnetic moment of the electron in the calibrating atoms, which we, of course, assumed to be the Bohr magneton. The magnetic moment of the proton in terms of the nuclear magneton that was found on the basis of the assumption that the spin moment of the electron was indeed the Bohr magneton differed from the moment as determined from the measurement of a frequency in a classically determined field by about 0.1 percent. When, at a much later date, it was found that the spin magnetic moment of the electron deviates from the Bohr magneton by the order of 0.1 percent, the direction of the deviation in the older experiment was examined. It is perhaps a good commentary on the hazards of experimental physics that no significant effect had escaped us but that the error in the mutual inductance which we had used in the calibration of the magnetic field was of the order of 0.2 percent rather than 0.1 percent.

After World War II, Nafe and Nelson, working with Rabi, made the first of the measurements of the hyperfine structure splitting of hydrogen in the ground state (6). Now the hyperfine structure of hydrogen may be calculated explicitly in terms of the magnetic moment of the proton, the spin magnetic moment of the electron, and the electronic wave function at the nucleus. However, a discrepancy of about $\frac{1}{4}$ percent was noted between the observed and predicted magnitude of the hyperfine structure splitting when the value of the proton moment found by Millman and me was used. The assumption that the spin moment of the electron is 1 Bohr magneton enters into the calculation twice—first as an intrinsic property of the electron and second in the calculation of the proton moment from the observed ratio of the proton moment and the spin moment of the electron. The discrepancy led Breit to suggest (7) that the electron may possess an intrinsic magnetic moment greater than μ_0 by the order of $\alpha\mu_0$, where α is the usual fine structure constant.

Anomalous Magnetic Moment

The question of the existence of an anomalous magnetic moment was then investigated in detail by Foley and me

(8). In this inquiry, as in all others conducted in the atomic and molecular beams laboratory at Columbia University, we profited by Rabi's advice. The procedure that we employed made use of the fact that the g_J value associated with a state is a linear combination of the electronic orbital and spin g values, g_L and g_S and that this combination is different for different states. That is, there is a contribution to the total electronic magnetic moment of an atom both from the orbital motion of the electrons and from the spin of the electrons; the contribution from each of these factors is dependent on the state of the atom. Since we considered only atoms with single electrons outside closed shells, Russell-Saunders coupling is a good approximation and the coefficients that relate the various g values are known. The ratio of the g_J values of two atoms that occur in different spectroscopic states yields g_S/g_L to an accuracy limited by the precision of observation and the precision with which the coefficients relating the various g values are known.

The intercomparison of g values to obtain a value of g_S can only be made if atoms in several different spectroscopic states are available for observation. After our first investigation of the hyperfine structures of the alkali atoms, all in the $^2S_{1/2}$ state, Hardy and Millman (9) studied the hyperfine structure of indium in the $^2P_{1/2}$ state. Just after the war, Becker and I (10) determined the interaction constants that characterize the hyperfine structure of both the isotopes of gallium in the $^2P_{1/2}$ state. Gallium atoms in the excited and metastable $^2P_{3/2}$ state also occur in an atomic beam, and it was possible to determine the interaction constants for both isotopes in this state as well. We thus had available for study atoms in three different spectroscopic states.

In principle, the determination of the ratio of two g_J values is simple. Suppose we observe transitions for which F is constant and m_F changes by ± 1 for two different atoms or for the same atom in two different states. To the extent to which strictly low field conditions prevail, all lines in a given F state have the same frequency, and the ratio of the frequencies of such lines in two different states at a fixed field is simply the ratio of the g_F values. From this ratio, the ratio g_S/g_L for the electron may readily be derived with some additional knowledge of the properties of the nucleus in each atom. However, the hyperfine structure splitting of atomic states is generally small (from 200 to 20,000 megacycles per second) and the energies of the levels are far from linearly dependent on magnetic field at usefully high fields. Nevertheless, it is possible to obtain expressions for the energies of all levels in the hyperfine structure in terms of the zero field hyper-

Table 1. Observed ratios of atomic g values and the corresponding values of g_S/g_L .

Comparison	Nominal	Observed	g_S/g_L
$g_J(^2P_{3/2}\text{Ga})/g_J(^2P_{1/2}\text{Ga})$	2	$2(1.00172 \pm 0.00006)$	$2(1.00114 \pm 0.00004)$
$g_J(^2S_{1/2}\text{Na})/g_J(^2P_{1/2}\text{Ga})$	3	$3(1.00242 \pm 0.00006)$	$2(1.00121 \pm 0.00003)$
$g_J(^2S_{1/2}\text{Na})/g_J(^2P_{1/2}\text{In})$	3	$3(1.00243 \pm 0.00010)$	$2(1.00121 \pm 0.00005)$

fine structure splitting, the ratio g_N/g_J , and the quantity $g_J\mu_0 H/h$, or, where such expressions cannot be explicitly found, to determine the energies from the appropriate secular determinants. From the observed frequencies of appropriate lines and with a prior knowledge of the interaction constants which characterize an atom in the state in question, it is then possible to determine $g_J\mu_0 H/h$. Measurement of this quantity at the same field for atoms in two different states yields, at once, the important ratio g_S/g_L . The determination is independent of a knowledge of the magnetic field and of any fundamental constants.

Experimental Details

It is, perhaps, worthwhile to remark on some experimental details. The field in which the transition frequency was measured was so chosen that all the observed lines had a frequency of the order of 1 megacycle per second, per gauss. To avoid excessive distortion of the lines due to inhomogeneity of the field, a great deal of adjustment of the field was required before the lines approximated in width their theoretical value.

Special arrangements were made to allow the rapid interchange of ovens so that lines of different atoms could be measured in rapid succession. A considerable number of oscillators was required so that several frequencies which differed by large factors could be applied to the radio-frequency circuits that induced the transitions. Although the lines should, in principle, be measured at a fixed if unknown field, the actual measurements were made in a field that varied monotonically throughout a series of observations. The variation of field has the annoying effect of requiring a large body of data to establish the frequencies of two or more lines at a fixed field, but it also aids in avoiding repetitive errors that may occur when a reading of a fixed quantity is repeated.

Three intercomparisons of g_J values were made in these experiments. The results are given in Table 1.

It is to be noted that the ratio g_S/g_L which has been determined has been found from the ratio of the g_J values on the basis of the assumption that the coupling is Russell-Saunders coupling. Hence the deviation of the ratio g_S/g_L from its nominal value of 2 as determined from any pair of atoms or any pair

of states does not constitute clear evidence that the spin moment of the electron is other than 1 Bohr magneton because of the possibility of occurrence of significant perturbations of the states. Theoretical arguments, however, indicate that such perturbations must be small. On experimental grounds, the agreement of the ratio obtained in three different ways from different atoms in different spectroscopic states offers overwhelming evidence that the spin moment of the electron does indeed differ from its nominal value by the indicated amount. The discrepancies between the three values of the ratio may, however, arise from perturbations of the indicated energy levels.

A later intercomparison of the g_J values of the alkali atoms and a comparison of the g_J value of potassium and hydrogen has demonstrated that the g_J values of the three alkali atoms of lowest atomic number are indeed equal to the spin g value of the electron to within 1 part in 40,000. A further intercomparison by Mann and me (11) of the g_J values of indium in the $^2P_{1/2}$ and $^2P_{3/2}$ states has given further confirmation to the interpretation of the discrepancy between a measured ratio of g_J values and the nominal value.

The experiments that have been described were performed at a field of about 400 gauss. In a wholly independent series of experiments, Taub and I (12) determined the ratio of the g_J value of indium in the $^2P_{1/2}$ state and that of sodium in the $^2S_{1/2}$ state by observations of lines in the hyperfine structure spectrum at fields that ranged from 3300 to 12,000 gauss. The method was to determine the nuclear g value of the proton in an alkali hydroxide in terms of the g_J values of indium and sodium. The result, insofar as it concerns the proton, is of no further interest here in view of the highly refined experiments which have been made in later years that allow the precise and direct determination of the nuclear g value of the proton in terms of both the nuclear and the Bohr magneton. The result, however, is of interest because it yields again the ratio of the g_J values in two different states on the basis of measurements at fields which differed from those in the earlier experiments by an order of magnitude. We found that

$$g_S/g_L = 2(1 + 0.00119)$$

We may therefore conclude on the basis of all evidence that the electron does in-

deed possess an "intrinsic" or "anomalous" magnetic moment over and above that deduced from the Dirac theory and whose magnitude is very close to 0.119 percent of the Bohr magneton.

Theoretical Interpretation

Perhaps it is well, at this point, to make a brief statement of the theoretical status of the spin magnetic moment of the electron. Soon after the publication of our first results, which gave substance to the assertion that the electron does have an anomalous moment, Schwinger (13) gave a result, based on new procedures in quantum electrodynamics, that

$$g_s/g_L = 2(1 + \alpha/2\pi) = 2(1.00116)$$

The result is in excellent agreement with experimental measurements of the same quantity. The effect of the increased electron moment arises essentially as a consequence of the quantization of the electromagnetic field which always has a residual zero-point amplitude. Although the existence of this field had previously been recognized, it had not been possible to deal with the interaction prior to the formulation of contemporary quantum electrodynamics. The importance of the observation of the anomalous magnetic moment of the electron is in part in the demonstration that the procedures of quantum electrodynamics are, in fact, satisfactory in formulating a description of nature.

High-Precision Measurements

It is obvious that a more detailed study of the magnetic moment of the electron than that described thus far was desirable. The objective of a more extended investigation lies in the avoidance of theoretical difficulties in the interpretation, to a high precision, of the electronic g values of complex atoms. In the absence of substantial difficulties of interpretation, the very great precision of which spectroscopy by the method of atomic beams is capable may be used to obtain results of sufficient precision to test the validity of the calculations of quantum electrodynamics when they are made to a higher order than those originally made by Schwinger.

Barring only a measurement of the spin moment of the free electron itself, the best measurement that one may hope to make is on the electron in the hydrogen atom. In this atom in the ground state, the electron has no orbital angular momentum and hence there is no contribution to the electronic magnetic moment from the orbital motion. The entire

electronic magnetic moment arises from the spin moment of the electron. Koenig, Prodell, and I (14) have determined the ratio of the electronic g value g_J of the hydrogen atom and the nuclear g value of the proton by experimental procedures to be described. To a very high order of accuracy, g_J is equal to g_s' , the spin g value of the electron bound in the hydrogen atom. The value of g_s' differs from g_s of the free electron through a small relativistic effect of about 18 parts per million. Corrections due to a mixing of states and relativistic effects are well known and do not limit the accuracy with which the ratio g_s/g_P may be determined at the present time. Gardner and Purcell (15) have measured the ratio $2g_L/g_P$ of the cyclotron frequency of the electron and the precession frequency of the proton in a magnetic field to an accuracy of about 1 part in 80,000. Our result, when combined with that of Gardner and Purcell, yields g_s/g_L .

As a preliminary procedure, Prodell and I (16) determined the hyperfine structure separation of hydrogen with high precision. A subsequent investigation by both Wittke and Dicke (17) and by us (18) indicated an excessively optimistic estimate of the uncertainty. However, the value of the zero field hyperfine structure splitting of hydrogen that we used was sufficiently good to contribute no error to the value of g_J/g_P that was comparable to other uncertainties.

The apparatus designed for the purpose of these experiments had for the magnet that determined the transition frequencies one with a much better field homogeneity than that which usually characterizes the magnets used in atomic beams experiments. Ordinarily in an atomic beams apparatus, the magnet that determines the splitting of the levels is internal to the vacuum system. This arrangement permits small magnet gaps to be used and hence the production of large fields with electromagnets of moderate dimensions and power consumption. The use of a small gap, however, leads to a considerable hazard of field inhomogeneity. In the present case, the magnet was external to the vacuum envelope, the pole faces were of large diameter to reduce edge effects, and the magnet could be carefully shimmed after each change of externally imposed experimental parameters and from day to day to give good homogeneity in the volume within which transitions were observed. The deflecting magnets consisted of current-carrying conductors rather than the iron magnets that have become conventional in atomic beams experiments. This choice was made because of the smaller distortion of the transition field by current-carrying conductors than by massive blocks of iron.

Results

The experiment involved the measurement of the frequency of transition between the levels $m=0$ and $m=-1$ in the state for which $F=1$ alternately with the proton resonance frequency in the same magnetic field. The frequency of the first of these lines is of the order of 3600 megacycles per second at a field of 1500 gauss. The frequency of the proton resonance line is about 6.5 megacycles per second at the same field and is found by the methods of nuclear resonance in the same region of space as that traversed by the beam. An important component of the equipment is a device that can insert a cylindrical sample of water or mineral oil into a region as closely coincident as inherent limitations permit to that in which the atomic line has been observed. Various small corrections relating to the residual inhomogeneity of the field, bulk diamagnetism of the matter in the cylindrical sample that we employed, the presence of paramagnetic ions when we observed the resonance in water, and the differential internal diamagnetic shielding between oil and water must be applied.

We found that

$$g_s/g_P = -658.2171 \pm 0.0006$$

where g_P is the nuclear g value observed in a spherical sample of mineral oil. It is to be noted that this is only an apparent value of g_P because the externally applied field is modified by the internal diamagnetic shielding of the proton by the electrons in the molecules containing the proton. It is, nevertheless, of value to give the result in this form since the ratio $2g_L/g_P$ measured by Gardner and Purcell also refers to a spherical sample of mineral oil.

Application of a small relativistic term yields g_s , the spin g value of the electron in terms of g_P :

$$g_s/g_P = -658.2288 \pm 0.0006$$

The combination of this result with that of Gardner and Purcell

$$2g_L/g_P = -657.475 \pm 0.008$$

yields

$$g_s/g_L = 2(1.001146 \pm 0.000012)$$

where the principle uncertainty arises from the result of Gardner and Purcell. Since g_L equals 1, we can write

$$g_s = 2\mu_s = 2(1.001146 \pm 0.000012)$$

where μ_s is the spin magnetic moment of the electron in terms of μ_B .

The same result has subsequently been obtained by Beringer and Heald (19), who used a different experimental method involving, for atomic hydrogen, a microwave absorption technique and,

for the observation of the proton resonance frequency, the usual nuclear resonance technique. The primary result obtained by them was

$$g_s/g_p = -658.2181 \pm 0.0003$$

In view of the stated uncertainties and the possibility of differences in the internal diamagnetic shielding in different samples of mineral oil, the agreement is good. Because of the limited accuracy for the result $2g_L/g_p$, the value of g_s/g_L is not affected, within the range of its uncertainty, by the discrepancy in the two results.

Conclusion

It is interesting to examine the ratio of g_s/g_L obtained by the sequence of experiments just described in light of the theoretical calculations of the electron moment. The result gives unambiguous evidence that the electron moment is anomalous and that the deviation of the

moment from its nominal value is about $\alpha\mu_0/2\pi$. Karplus and Kroll (20) have calculated to a higher order the radiative correction to the spin moment of the electron and have found for the spin g value

$$g_s = 2(1 + \alpha/2\pi - 2.973 \alpha^2/\pi^2) = 2(1.0011454)$$

The result of the experiment is in remarkable agreement with the calculation, especially since the uncertainty in the experiment is much greater than the discrepancy between the experimental and calculated values. The agreement offers conclusive evidence of the validity of the calculation to the order α and very strong support to the validity of the calculations to the order α^2 . Thus the new procedures of quantum electrodynamics—which have, perhaps, a questionable *a priori* validity—are demonstrated to be, in practice, valid for the interpretation of certain observed phenomena and, therefore, useful in the exploration of other aspects of the behavior of matter.

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Airborne Radioactivity

Eizo Tajima and Tadayoshi Doke

Artificial radioactivity, in addition to the natural activity in the atmosphere, has been observed after atomic bomb tests. Other investigations in this field might be in progress, but few articles are available. Relatively thorough documents have been published by M. Eisenbud and J. H. Harley on radioactive fallout in the United States (1, 2). The present report describes the results of measurements of airborne radioactivity in Japan from 16 March to 4 May 1955 (3). We could detect not only the radon and thoron daughter products but also artificial radioactivity, including alpha emitters. The artificial radioactivity appears to have two or more components of different origins. The correlation of the daily variation with meteorological conditions is shown.

The air samplers used in this experiment were of the same type as the "coffee

pot" sampler that was presented to the Japanese Science Council by the United States at the Japan-United States Radiobiological Conference that was held in the fall of 1954. A fan draws the air through a No. 41 Whatman filter paper 11 centimeters in diameter. The filter efficiency for normal dust is said to be high but it is not known for fine dust. Although a membrane filter has a higher efficiency for fine dust, it could not be used because the small air flow is not enough to cool the fan motor.

The change in flow rate of the air was checked by an anemometer because clogging of the filter paper might decrease it. The initial rate of the air flow was 27 cubic meters per hour; the rate did not change during the 24 hours of operation. On an average, the flow of the air for 24 hours of operation could be measured as 650 cubic meters with an

error of less than ± 10 percent. Little difference was observed among the three samplers that were used.

The efficiency of the filter paper was checked at high humidity. A pair of samplers was made to draw the air through chimneys that were each 3 meters in length and 11.5 centimeters in diameter. One of the chimneys was furnished with a long water-filled boat and a Nichrome winding. After 4 hours' simultaneous operation of both samplers, the natural radioactivity on the filter paper was measured. About 70 milliliters of water was evaporated during the period of operation. The cleaning efficiency of the filter paper in moist air was found to be only 4 percent greater than it was for ordinary air.

The filter papers were ashed in a crucible and the beta radioactivity of the ash was measured by a conventional Geiger-Müller counter with a mica window. The counting efficiency was estimated at 16.6 percent from a 75-disintegration-per-minute substandard of Ra-E. The activity of all samples was measured once a day for about 1 month to get the decay curve. Aluminum absorption curves of some samples of special interest were also run.

For alpha measurements, a scintillation counter with adjustable sample-to-phosphor distance was used. The counting efficiency for alpha particles of 5.3 Mev

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was 16.7 percent with the afore-mentioned Ra-E substandard, measured at a distance of 8 millimeters from the phosphor. The background was 2 counts per minute and remained constant. The range of alpha particles was measured by changing the distance between the phosphor and the source; it was also measured with an integral pulse discriminator.

Natural Radioactivity

After the air sampler had been operated for a few hours, natural radioactivity was detected. From the decay curve, its apparent half-life was about 40 minutes, which shows that the activity was due to radon daughter products. There were occasional slight changes in the decay curve; these were considered to be caused by a change in the concentration of the daughter products in the atmosphere (4).

When the sampling time was extended to more than 3 hours, the intensity of the activity reached saturation. On the basis of the saturation value and the flow rate

of the sampler, the radon daughter products in the air were estimated to be of the order 10^{-13} curies per liter, assuming that they were in equilibrium (5). The concentration of the radon daughter products was larger at night than it was in the daytime because of temperature inversion (6).

After continuous operation of the air sampler for 24 hours, activity with a half-life of 10 to 12 ($T_{1/2} = 10.6$ hours) hours appeared in every case. The ratio of alpha- to beta-disintegration rates was about 0.5, which is compatible with the activity owing to thoron daughter products (7).

Artificial Radioactivity

Daily variations in intensity as well as half-life were observed for the residual activity. Figure 1 shows the daily change in intensity. The date is plotted on the abscissa and the activity at 72 hours after sampling is plotted on the ordinate. This was enough time to insure that the natural radioactivity had died out. The measurements covered the period from 16

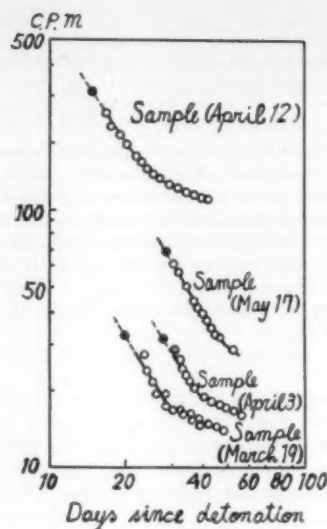


Fig. 2. Log-log plots of the radioactivities.

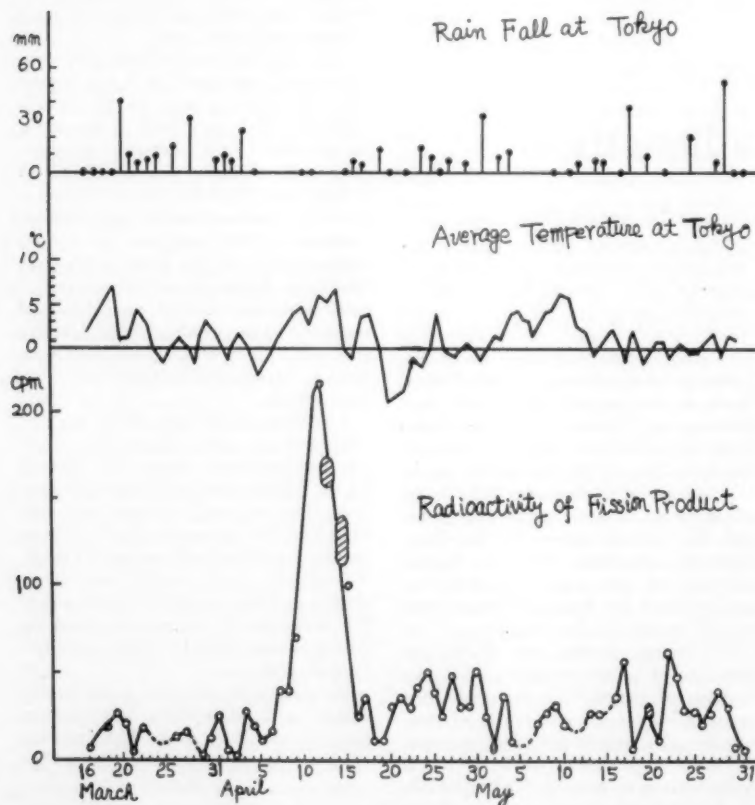


Fig. 1. Daily changes of radioactivity of fission products, average temperature, and rain-fall at Tokyo.

March to 31 May; many maxima were observed during this time. The error of the measurement was at most 20 percent except in a few cases that had a larger error because of instrument trouble. These cases are represented by hatched marks in Fig. 1. On 31 March, a simultaneous sampling was made at Ichikawa, which is 20 kilometers from Tokyo, and the result was within the experimental error of the sampling at our university. Almost all the samples followed almost the same decay curve of a long half-life (about 25 days); the few exceptions were cases in which appreciable decrease in activity has not yet been observed.

This activity may be attributed to artificial radioactivity and not to naturally existing isotopes in the soil that might be concentrated on the filter paper. There are no natural radioisotopes whose half-life would fit the decay curve and which have the high specific beta activity that was found in the samples. Therefore, the nondecaying activity could be considered as aged fission products, and the decaying activity (25 days) could be considered as fresh fission products or a mixture of the two.

The aluminum absorption curve of the beta activity of 12 April measured 1 week after sampling gave three components whose half-thicknesses were 2, 43, and 112 milligram per square centimeter of aluminum, while the analysis of the sample of 3 April at 5 weeks after sampling gave two components of half-thicknesses 7 and 140 milligrams per square centimeter of aluminum. All the samples seem to belong to one of these two types, as shown in Table 1. The three component samples of the 12 April measure-

ment were of shorter half-life than the two component samples of the 3 April measurement.

Let us assume the intensity of the activity follows the well-known relationship

$$I = At^{-1.3 \sim -1.4},$$

where I is the intensity, A is the constant, and t is the time that has passed since nuclear fission took place (8). The date of the detonation can be determined by plotting the points on a log-log graph, taking an appropriate t so that a straight line of slope $-1.3 \sim -1.4$ may be drawn. However, in every case in the present experiment, the latter points deviated from a straight line as shown in Fig. 2 if the earlier points were aligned. This would imply that the gross activity is composed of two, or more than two, components of different origins. The date determined thus is the earliest possible date of the latest detonation, and the dates of detonations are tabulated in Table 1 with this meaning.

Alpha activity was measured on 2 May 1955 by the scintillation counter and is shown in Table 1. There is very little possibility that the alpha activity should be attributed to radon or thoron daughter products or to natural uranium from the soil that might have been collected on

Table 1. Results of the measurement of airborne radioactivity.

Date of sampling (1955)	Beta activity (count/min)	Alpha activity on 2 May (count/30 min)	Energy of beta rays		Estimated date of detonation (1955)
			Date	Half-thickness (mg/cm ²)	
19 March	27	22			1 March
20 March	23				1 March
31 March	23	54	2 April	7, 160	Before 1 January
3 April	28	56	7 May	7, 140	7 March
5 April	10	21			
8 April	40				12 and 29 March
12 April	220	126	19 April	2, 34, 112	29 March
13 April	50	76	8 May	2, 29, 150	29 March
14 April	130	54	8 May	2, 30, ?	
15 April	100		9 May	10, 120	Before 1 January
19 April	10	0			
24 April	50	54	23 May	7, 150	7 March
17 May	55	0	29 June	12, 200	15 April
22 May	60	0	28 June	12, 200	25 April

the filter paper. Daughter products are excluded because the measurement was made as long as a month after the sampling, and uranium is excluded by the fact that the uranium concentration in the soil would have to be from 0.01 to 0.1 percent. This was verified by a meas-

urement that showed no alpha activity in 40 milligrams of soil, which was twice as much as the average ash content of our samples.

Discussion

Although it was difficult to determine the cleaning efficiency of the Whatman No. 41 filter paper for radioactive dust, it seemed reasonable to assume that the efficiency is, on the average, 40 percent for normal dust and 10 percent for the small dust (5). Then the concentration of the radioactive dust of the fission products in the air could be calculated as $3 \times 10^{-13} \sim 1.2 \times 10^{-14}$ curies per liter on 12 April; this is comparable to the concentration of natural radioactivity of the atmosphere (1).

As mentioned in a previous paragraph, two kinds of aluminum absorption curves and two kinds of decay curves were observed. They have a tendency to correspond—that is, the beta activity that showed three components by absorption tended to decay faster than samples that showed two components. Moreover, when transition of the apparent half-life from the shorter to the longer period took place, a transition in the beta-ray energies could also be observed, although there was some uncertainty in this observation. This is one argument that the activity might have two or more components of different origins.

There were many cases in which the detonations could be considered to have taken place about 10 days before sampling. These detonations might have been the series of tests in Nevada that started on 18 February and ended 15

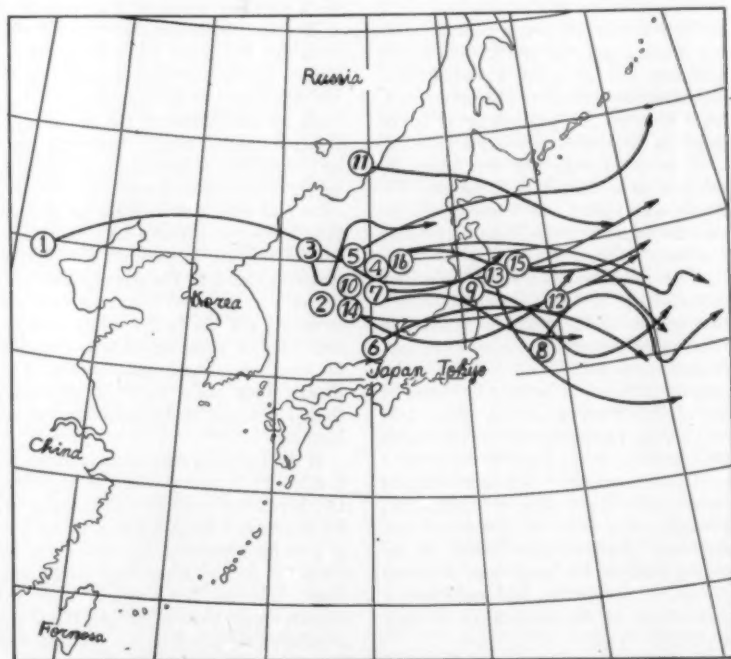


Fig. 3. Trajectories of high atmospheric pressure on the day when the peak of activity appeared. Dates as follows: 1, 19 March; 2, 22 March; 3, 27 March; 4, 31 March; 5, 2 April; 6, 12 April; 7, 21 April; 8, 24 April; 9, 27 April; 10, 30 April; 11, 3 May; 12, 9 May; 13, 17 May; 14, 20 May; 15, 22 May; 16, 28 May.

May 1955. It is possible for the activity to travel from Nevada across the Atlantic Ocean to Tokyo in about 10 days if the dust is carried by the jet stream with a speed of about 55 to 70 kilometers per hour.

The meteorological phenomena that might have a correlation with the daily change of the activity of the fission products are shown in Fig. 1 and Fig. 3. Although the reason is not clear, the average temperature seems to show a good correlation during April, but not in May. Rainfall might be expected to clean up the radioactive dust in the air; however, it shows only a slight correlation,

which implies that rainfall does not completely clean up the contaminated air. The location of high pressure areas shows better correlation insofar as our present observation is concerned. Figure 3 shows the trajectories of high atmospheric pressure centers during the period studied. When the activity shows a maximum on the curve in Fig. 1, the trajectories passed through the neighborhood of Japan. On the other hand, when the activity was at a minimum, the trajectories diverged away from Japan without exception. The radioactive dust might have been carried by the jet stream 7 to 10 kilometers above the ground, and the

dust might have fallen to the ground along the trajectories of high atmospheric pressure.

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W. L. Bryan, Scientist, Philosopher, Educator

On 8 July 1892, Clark University was the scene of an important scientific event. On that date the American Psychological Association was founded. Of the 31 original members of this new organization, not all were professional psychologists; among them were several psychiatrists and a number of philosophers. Even those who could technically be called psychologists were not far removed from theological, philosophic, and academic-administration interests.

Yet this organization signalizes for American psychology the establishment and growth of the laboratory tradition. This institutionalizing of experimental study has proved to be a powerful factor in the evolution of psychology toward a high peak of proficiency and performance within the great family of sciences. Since the scientific enterprise is above all a persistent search for the nature of things, it may well be, and often is, carried out under widely different auspices. An organization, therefore, that fostered an accumulation of facts and techniques could not fail to produce a beneficial impact upon science in general.

William Lowe Bryan was an effective participant both in the establishment of the American Psychological Association and in the direct development of sci-

tific psychology. He was a charter member of this association and in 1903 was its president. But this is only a symbol of his psychological interests. His more intimate concern for psychology is to be found in his unique *curriculum vitae*.

When psychology was first being developed as a science in Germany, Dr. Bryan was among the early American students to study there. Later he became a pioneer in the experimental investigation of the development of voluntary motor ability and the learning processes that are involved in attaining skill in telegraphic transmission and reception. In connection with his researches on telegraphic language he worked out some of the earliest learning curves, which still find a large place in textbook literature. Dr. Bryan's investigations became a model for a number of human-learning experiments. Even after retiring, at an advanced age, from his prolonged and successful administrative duties, he resumed work on the psychology of learning a life occupation and published a monograph on this subject as recently as 1941.

In addition to his own studies, Dr. Bryan, throughout his long life, actively supported psychology, as well as other scientific work. As founder of the psy-

chological laboratory at Indiana University, as head of the philosophy and psychology department, and later as president of Indiana University, he constantly demonstrated his eagerness to promote psychological research, both morally and financially.

Dr. Bryan, however, was by no means narrow in his interests. For example, he never relinquished his study of philosophy and published several volumes on Plato in collaboration with his wife, Charlotte Lowe Bryan. He also found time to add the promotion of education on a national scope to his program of university, local community, and state activities. For many years he acted as a trustee of the Carnegie Foundation for the Advancement of Teaching.

As an administrator, Dr. Bryan was a living refutation of the frequently made statement that to become an administrator is to withdraw personally from science and scholarship. What he was unable himself to perform he compensated for by making it possible for his colleagues to achieve. He accomplished this, not only by personal encouragement and monetary aid, but by defending scientists and scholars from the attacks launched by vociferous bigots who presumed to dictate that their form of orthodoxy should be taught in institutions of higher learning.

If the esteem a man commands in his community is any measure of greatness, Dr. Bryan achieved that distinction. By his gentle and frank manner, by his loyalty to his principles, his duties and his vocation, and by his valued public orations, William Lowe Bryan endeared himself deeply to many people. His death at the age of 95 is felt as a personal loss by a host of friends and admirers.

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R. Paget and Human Speech

Richard (Arthur Surtees) Paget studied formally at Eton and Magdalen College, Oxford, and entered law. His professional career holds limited interest to scientists, although it contributed to Sir Richard's administrative appointment to the Admiralty Board of Invention and Research in World War I. In this post his flair for avocational interests and his bent toward matters of science were rewarding. The interests that eventually led to major contributions included acoustics, phonetics, the sign language of the deaf, and, his avowed lack of information notwithstanding, linguistics.

The searching inquirer who pursues a hobby beyond the level of the dilettante has some advantages over his more formally trained colleagues who hold the unofficial rank of specialists. He can be more daring. Sir Richard exemplified this favorable position both in his quest for information about speech and language and in the theoretical views that he postulated. Frequently in his *Human Speech* (1930) he recounted the steps that led him to noteworthy observations only to discover subsequently that he had confirmed or was in disagreement with the earlier work of an expert.

Sir Richard's interest in speech was comprehensive, encompassing essentially the communication system: the speaker, the language, and the receiver. These segments, however, he explored unevenly, and only a few aspects will be singled out for mention here.

Spectral analyses of the acoustic patterns of speech were made many times by ear prior to the electronic era. Paget, unaware of the earlier results, made yet another ear-analysis and formulated a systematic set of results that showed dual formants or frequency bands as typifying each vowel sound. The motivation for this analysis may have had roots in some observations and speculations about voices during his youthful college period, and was reinforced by practical matters

of acoustics during World War I, particularly in connection with the submarine. The analysis was realized during a period of confinement in 1921. These results anticipated the confirming description of the sounds of English speech yielded by well-equipped laboratories.

The investigator who takes apart the acoustic spectrum of speech is often moved to make the process work in reverse. Aside from applied considerations, success in synthesizing speech tends to confirm both the rational planning and correctness in the execution of the analytic steps. Any listing of "speech makers" from de Kempelen (1791) to a current generation of engineers in telephone and governmental laboratories and in universities would include Paget. His observations of two formants for each vowel led him to devise double-resonator models, and these proved capable of emitting vowel-like sounds.

Russell (*Speech and Voice*, 1931) tabulated the correct identifications that American listeners made while naming the artificial vowels generated by Paget with his series of resonator models. This intelligibility test yielded a range of values from chance to 75 percent, with the errors clustering about vowel sounds that bore a close physiological correspondence to the intended ones. The production of synthesized sentences was more impressive than the production of isolated vowels, and Paget enlivened the meetings of several learned societies, including an International Congress of Phonetic Sciences (1932), by producing short sentences with little equipment, indeed, on some occasions, with no more than cupped hands and a reed.

The rationale that suited both the analyzing and synthesizing of the acoustic patterns of speech accommodated as well a theory for the origin and development of speech. Paget advocated the theory that the roots of speech lay in universal gestures. Eventually these postures and

movements of the body and hands were copied in the mouth and became singular shapes of the oral cavity and of the ancillary bunched tongue. The incidental forming of front and back cavities (resonators) of varied sizes was fortuitous; they and the pipelike connector over the bunched tongue accommodated the formation of dual-formant vowels. A whispered accompaniment to the several positions of the mouth amounted to distinctive acoustic "signs" that came to replace the significance of the visual gestures. The mobility of the gesture-making parts of the mouth facilitated the development of successive and complicated signs: words. This whispered speech, the basis for at least the Indo-European language, became vocal when man learned of the greater distance that vocalized signs would carry relative to whispered ones.

Although Paget might have been content to let his stake in the gesture theory rest on internal evidence offered by the European languages, his friends bolstered his case for him considerably by providing confirming examples from Asiatic and Pacific languages. His "clinker" lay in a fabricated language. He conceived of an action or an object, tried to convey the essence of the "thought" by "hand and facial action." He then transferred the movements to the mouth and whispered while making the gesture. The phonetic accompaniment of the gesture was transcribed and given to students of primitive languages who reported that in nine of ten instances near relatives of the artificial symbols are found in current primitive languages and are associated with the meanings conjectured by Paget.

Paget's further range of topics included abnormal speech (including postlaryngectomy talking), speaking horns, and language reform. His description of the production of esophageal speech is penetrating. A reader today possibly finds the backward spanning of time too easy as he reads "modulated air stream" into automobile horns that were made to talk in the 1920's, and as he notes strong hints of information theory, sans bits, in a description of the evidences of inefficiency of the English language.

Sir Richard died in October 1955 at the age of 86. Two years earlier he was president of the British Deaf and Dumb Association, continuing a scholarly interest in the production and the identification of signs in human communication.

JOHN W. BLACK

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There are no gains without pains.—BENJAMIN FRANKLIN.

News of Science

CERN Progress in 1955

The report on the work of the European Organization for Nuclear Research (CERN) that was presented at the fourth session of the CERN Council 19-20 Dec. covered the period February to November 1955. It is a record of considerable achievement and progress in all the various activities. In particular, schedules for both the machines and the buildings have been well maintained.

For the proton synchrotron, the chief effort has been devoted to developing the component parts of the machine and investigating the European sources of equipment supply. The main orders for the magnet will be placed early in 1956 and the facility is expected to go into operation in 1960. In the light of further experience, a reassessment of the cost of the machine (including the buildings) has given a figure of F. 86 million (Swiss).

The smaller machine, the synchrocyclotron, is at a more advanced stage. The erection of the magnet in its building at Meyrin was started at the beginning of November. Nearly all the component parts of the synchrocyclotron are in the course of manufacture. Since this machine will be put into operation in 1957, the research program for its use is now being planned.

Instruments, mainly electronic in nature and in some cases of new design, and experimental methods to be used when the machines start working, have been developed during the year. The construction of the two Wilson cloud chambers is well advanced, and the first one has been assembled and is undergoing preliminary tests.

The CERN section in Copenhagen, in addition to carrying out fundamental research in nuclear physics, has continued its program for training young theoretical physicists from member states.

Two important budgetary measures were approved at the council meeting: the estimates for the financial year 1956, and the capital investment program for the period 1952-1960. The budgetary contributions for 1956 have been fixed at about F. 34 million (Swiss) as compared with a figure of F. 25 million for 1955. The coming year will be the period of

great activity—a general move to the site at Meyrin, the installation of the laboratories and workshops, and the development of the scientific program in relation to experiments with the machines.

The staff, which is drawn from each of the 12 participating countries, will be increased by about 40 percent. It has grown rapidly in pace with the expansion of the organization and now consists of 285 persons. In 1956 it is expected that the total staff will reach a figure of about 400.

Albert Schweitzer

An extensive collection of Albert Schweitzer memorabilia was placed on exhibition in the Princeton University Library on 14 Jan. in honor of Schweitzer's 81st birthday. The collection includes samples of writings and commemoratives by others. The display also has photographs lent by Erica Anderson, co-author of *The World of Albert Schweitzer*, showing the scientist at work in Alsace and Africa.

Schweitzer's publications, from 1898 to his most recent work in 1955, are divided into sections representing New Testament scholarship, philosophy of civilization, music, medicine, philanthropy, and autobiography. Also included in the exhibition is a selection of letters to Walter Lowrie of Princeton, a member of the class of 1880 who translated one of Schweitzer's books in 1913. The story of Schweitzer's hospital at Lambaréné, French Equatorial Africa, is told in a series of reports printed and translated by his friends.

Rockefeller Institute Graduate Program

The Rockefeller Institute has recently announced the details of its plans for establishing a graduate academic program in the biological sciences [*Science* 122, 279 (12 Aug. 1955)]. In November 1954 the institute's original charter was amended to permit granting the degrees of doctor of philosophy and doctor of medical science. The institute thus became a graduate university.

All of the resources of the institute will be available to the limited number of selected students who will be admitted. These resources include a faculty numbering approximately 150, to which group more members will be added as fields of research expand; large well-equipped laboratories; a hospital for the study of disease in man; and a comprehensive scientific library. These physical resources are located in six modern buildings on a campus of more than a dozen acres close to the Cornell Medical College, New York Hospital, Memorial Hospital, and the Sloan-Kettering Institute. To the present facilities there will be added new laboratories and a residence hall for students. The present value of the institute's endowment approximates \$150 million.

Two types of students will be admitted: those who have just completed their undergraduate training for the baccalaureate, and those who are doctors of medicine and wish to prepare for careers of research and teaching. Both groups will be candidates for the Ph.D. degree after a period of no less than 3 years, although those who already hold the M.D. degree may elect the degree of doctor of medical science.

Probably no more than 15 to 20 students will be admitted each year. Accordingly, the student body will ultimately number approximately 60 to 75. This small group will be able to have close association with a large faculty. The educational program will be adjusted to fulfill the needs of each student.

Throughout the first academic year 2 hours of each morning will be devoted to lectures, seminars, and discussions of related subjects in many fields of science; together these sessions will comprise an orientation course in the pattern and structure of biology and the related sciences. Each week a topic will be discussed by one or a group of the faculty who are actively engaged in research in that area of science.

In order to broaden further the students' intellectual horizons, many distinguished scientists from this country and abroad have been appointed visiting lecturers. They include: Lord Adrian, master of Trinity College, Cambridge, England; Jan A. Böök, Statens Rasbiologiska Institut, Uppsala, Sweden; John C. Bugher, director for medical education and public health, the Rockefeller Foundation; M. Demerec, director, department of genetics, Carnegie Institution of Washington; Ludwig Edelstein, professor of humanistic studies, Johns Hopkins University; David R. Goddard, chairman, department of botany, University of Pennsylvania; Samuel A. Goudsmit, chairman, department of physics, Brookhaven National Laboratory; Ragner Granit, professor of neuro-

physiology, Karolinska Institute and director of the Nobel Institute for Neurophysiology, Stockholm, Sweden; Leland J. Haworth, director, Brookhaven National Laboratory; John G. Kirkwood, Sterling professor of chemistry, Yale University; A. Monnier, professor of psychophysiology, University of Paris at the Sorbonne, Paris, France; John S. Nicholas, Sterling professor of biology, Yale University; I. I. Rabi, Higgins professor of physics, Columbia University; William J. Robbins, director, New York Botanical Garden; Alexander von Muralto, professor of physiology, University of Bern, Switzerland. Each of these lecturers will spend a week with the students.

As the students' interests develop, they will be encouraged to spend not less than a year in study under leading scholars in two or three other universities anywhere in the world. The institute will defray the expense of this travel and study, both as an investment in the students' future and as an aid to cooperation between universities.

Further, the institute will invite students in other graduate schools to study at the institute for brief periods during which seminars will be held in subjects relevant to their interests. Travel grants will be provided for this purpose, and the visiting students will be guests of the institute.

In October 1955 the institute enrolled an experimental class of ten students. To select this initial class, each of the presidents of a specially chosen group of liberal arts colleges, and the chairmen of some departments in large universities, were entrusted with the appointment of a 1955 graduate of his college or university to an institute fellowship. These fellowships carry an annual stipend of \$2500, with an additional \$1000 for travel and attendance at other universities. From Dartmouth, Amherst, Smith, Wesleyan, Yale, Union, Haverford, Pennsylvania, and Oslo came the first ten men and women to be enrolled. Next year the number of selecting universities will be increased and five graduates of medical schools will be added.

U. S. Rubber Research

Government contracts supporting synthetic rubber research, which costs about \$1 million annually, should end in June 1956, according to recommendations contained in the report of the Special Commission for Rubber Research of the National Science Foundation. The commission found that the national interest no longer requires Government support of research especially directed toward synthetic rubber.

However, the commission expressed

the view that basic research in general should receive a larger measure of support from the Federal Government and recommended that the National Science Foundation should, in fiscal year 1957, "support a new and more basic program made up of research projects in the general area of molecular structure and arrangement, composition and properties of high polymers, particularly elastomers, and methods of preparing such materials."

Decimals for India

In India this year, the currency system of rupees, annas, and pies—12 pies to the anna, 16 annas to the rupee—will be replaced by a decimal currency based on 100 pies to the rupee. On 2 Oct., Gandhi's birthday, the decimal currency will be introduced. Meanwhile, there will be an extensive program of village education.

Further, the system of weights and measures is to be replaced by the metric system. A recent survey of some 1000 villages by the Planning Commission of India showed that there are almost 150 different systems of weight measurement in effect and that there are even more complex systems for measurement of volume and land area.

The first place for change will be in the army, where soldiers will begin to draw rations on the metric system. Then railway markers will be changed from furlongs to kilometers. The Government estimates that at least 15 years will be required to complete the transition process.

Research Support by Private Foundations

The role played by privately endowed foundations in supporting scientific research in the United States is shown in *Scientific Research Expenditures by the Larger Private Foundations*, the report of a survey sponsored by the National Science Foundation that was released on 27 Jan. The study, prepared by F. Emerson Andrews of the Russell Sage Foundation, is one of a series which, when completed, will survey total scientific research expenditure for the nation.

Information was obtained on expenditures by 77 large endowed foundations during 1939, 1946, and 1953 for research in the life sciences, the physical, mathematical, and engineering sciences, and in the social sciences. For 1953 total expenditures of the 77 amounted to approximately \$164 million, less than 4 percent of the total amount spent for philanthropy in the United States.

Of the \$164 million, \$26 million was

spent for scientific research, less than 1 percent of the estimated national total for all research and development. Only 43 of the 77 major foundations supported scientific research.

Division of the 26 million dollars expended for scientific research was as follows: \$11 million for social sciences, \$12.5 million for life sciences—biological, agricultural, and medical—and \$2.5 million for physical sciences. Although basic research accounted for \$17 million and applied research for \$9 million, the proportion of private foundation funds spent for basic research compared with applied has decreased from 96 percent in 1939, to 75 percent in 1946, to 65 percent in 1953.

Bulletin of the Atomic Scientists

The January issue of the *Bulletin of the Atomic Scientists* marks the tenth anniversary of the journal, which was established in December 1945 by Hyman H. Goldsmith, a physicist, and Eugene Rabinowitch, a physical chemist, who is the present editor. Rabinowitch's commemorative article in the anniversary issue opens with the following paragraph about the *Bulletin*.

"... It was founded by a group of scientists whose participation in the development of the atomic bomb convinced them that, with this discovery, a radical change had come in the role of science in public affairs. They believed that mankind was entering, unawares, into a new age, fraught with unprecedented dangers of destruction. In spring 1945, this conviction led some scientists to an attempt—perhaps the first one in history—to interfere, as scientists, with the political and military decision of the nation. Leo Szilard's memorandum to President Roosevelt (March 1945) and the report to the Secretary of War by the so-called 'Franck Committee' on June 11, 1952, counseling, for reasons of long-range policy, against the use of atomic bombs in Japan, were the first manifestations of this new concern of scientists with public policy."

Toward the end of his article Rabinowitch says:

"As scientists, we probably all—or almost all—agree that no solution can be based on the negation of facts, or a refusal to evaluate them as objectively as possible; and that much of the world's hopes are based today on such negation and refusal. Explaining and analyzing facts, and educating public opinion to their acceptance, whether they are pleasant or not, has been one of the tasks of the *Bulletin* from its inception; and to this task it will remain dedicated.

"However, facts alone do not suggest action, unless a final aim has been set.

This aim is, to our mind, the survival and progress of civilized society; and the analysis of the facts of the atomic age seems to show convincingly that this survival depends on the development of ethical standards at once broader and higher than practical men have been prepared to accept and live by—broader in that they have to embrace all mankind and not just a single nation; and higher, in that they have to renounce selfishness and the resort to naked power, not only in relations between individuals within a nation, but also between nations."

Sea Water Conversion

Progress toward low-cost conversion of sea water and brackish inland waters to fresh water was reported by Secretary of the Interior Douglas McKay in his annual report to the President and the Congress on the conversion program. McKay stated that:

"Estimates of the probable cost of large-scale conversion of sea water show that it is approaching the maximum existing costs of municipal water in the United States and is considerably below those of industrial water, although still several times higher than those of currently used irrigation supplies. At the same time economical improvement of brackish waters for many irrigation uses, which is inherently less expensive than conversion of sea water, is definitely in sight."

During the past year, eight additional research contracts were entered into, bringing the total to 30. In all, 25 projects were in progress during part or all of the year. With few exceptions, the contracts call for specific performance. Their duration generally is for a year or less. Investigations are being carried out on distillation and sealing; performance of membranes, both electric and osmotic; solar distillation; freezing processes; and several processes not yet fully explored, including chemical, physical, and electric.

U.S. Population, 1955

The population of the United States, including the Armed Forces overseas, reached 166,740,000 by the end of 1955. This marked an increase of 2,810,000 during the year, only 13,000 less than the record set in 1954. Thus, the high rate of population growth that began in 1946 has continued unabated for a decade. About 26 million people have been added to our population in the past 10 years, a larger number than in the preceding 21 years.

Infant mortality declined to a new low rate of 26.4 per 1000 live births.

This is about 1½ percent below the previous minimum established the year before and 30 percent under the rate in 1945. The death rate for the population as a whole was about 9.3 per 1000, or only a shade above the all-time low of 9.2 recorded in 1954.

Scientists in the News

AHMED MUSTAFA, organic chemist and a professor at Cairo University, Cairo, Egypt, is spending a semester at Indiana University as a research associate under the auspices of the U.S. State Department. He is participating in a research program on organic sulfur chemistry.

During the next semester, Mustafa will be at the University of Rochester for research on photochemical aspects of organic sulfur chemistry. Mustafa has held guest fellowships at Massachusetts Institute of Technology, 1948-49, and at Columbia University, 1949-50.

CHARLES OBERLING, Roussy Institut anti-cancereuse, Ville Juif, Paris, France, is another of the participants in the decennial review Conference of the Tissue Culture Association that will take place in Woodstock, Vt., 8-12 Oct. [*Science* 122, 32 (6 Jan. 1956)].

MORRIS M. LEIGHTON, chief emeritus of the Illinois State Geological Survey, was honored on 11 Oct. at a dinner commemorating the survey's 50th anniversary. He was presented with a bound volume of nearly 200 letters from the mineral industries of the state and from colleagues throughout the nation expressing their appreciation of his services and scientific contributions during the past 36 years.

HARRY F. OLSON, director of the acoustical and electromechanical research laboratory of the R.C.A. Laboratories, David Sarnoff Research Center, Princeton, N.J., has received the John Scott award for a 25-year-old invention—the velocity microphone. This instrument revolutionized the technique of sound pickup in the early 1930's and is still the standard microphone throughout the broadcasting and motion picture industries. The \$1000 prize was presented during a dinner meeting of the Engineers' Club of Philadelphia. The award, which is administered by the city of Philadelphia, was established in 1816 by John Scott for "ingenious men and women who make useful inventions."

HANS J. TRURNIT, for more than 8 years staff scientist at the Medical Laboratories, Army Chemical Center, Md., has joined RIAS, Inc.

HENRY B. BIGELOW, oceanographer and professor emeritus of Harvard University, was honored on 24 Jan. on the occasion of the 25th anniversary of the Woods Hole Oceanographic Institution, which he helped to found. He served as its first director from 1930 to 1940.

A leatherbound copy of the *Bigelow Volume*, a collection of 48 original scientific contributions that was prepared by colleagues and former students, was presented to Bigelow by Columbus O'D. Iselin in a ceremony that took place in the Museum of Comparative Zoology at Harvard, where Bigelow has been working since the early 1900's. The 500-page honorary volume is a supplement to *Deep Sea Research* and will be distributed to all who subscribe to that periodical.

SAMUEL MARTIN will assume his new post as head of the department of medicine in the College of Medicine at the University of Florida on 1 Apr. He also will be coordinator of the J. Hillis Miller Health Center Study, which is supported by the Commonwealth Fund of New York.

At present Martin is associate professor of medicine and assistant professor of bacteriology at Duke University School of Medicine, where he was a Markle scholar from 1950 to 1955. He has conducted research on leukocytes and on tissue reaction to infection.

FRED HONKALA, associate professor of geology at Montana State University, was appointed chairman of the department on 5 Jan.

THOMAS COCKBURN, who has been in charge of research projects at the Communicable Disease Center, Atlanta, Ga., has accepted an appointment with the World Health Organization. During the next 2 years he will be epidemiologist to a communicable disease control project in Colombo, Ceylon. Cockburn left the United States early in January; communications should be sent care of the Ministry of Health, Colombo.

MARK W. ALLAM, dean of the School of Veterinary Medicine of the University of Pennsylvania, has left for Mexico as international consultant to the National School of Veterinary Medicine there. His assignment is being carried out under the auspices of the Pan American Sanitary Bureau, Regional Office of the World Health Organization. At the invitation of Latin American countries, a project is being established that is designed to assist in raising the teaching levels within the schools of veterinary medicine and to incorporate more practical aspects into the curricula.

MILTON A. CHAFFEE, former deputy director of systems at the Air Force Cambridge Research Center, Cambridge, Mass., has been appointed director of electronics and systems research at the Fairchild Camera and Instrument Corporation, Syosset, N.Y.

CHARLES P. HUTTRER, executive secretary of the physiology study section and of the morphology and genetics study section at the National Institutes of Health, has resigned from the latter to become consultant and executive secretary for the Pharmacology-Biochemistry Panel of the Cancer Chemotherapy National Service Center, National Cancer Institute, NIH.

HENRY F. PAYNE, who recently retired from the American Cyanamid Company, has been named research professor in charge of instruction and research on organic coatings in the department of chemical engineering, University of Florida.

JOHN E. MANGELSDORF has joined the missile systems division of Lockheed Aircraft Corporation, Van Nuys, Calif. He was previously a research fellow at the Laboratory of Aviation Psychology, Ohio State University, where he was on leave of absence from Dunlap and Associates, Inc., Stamford, Conn.

HERBERT F. MARCO, chairman of the mechanics division at the Air University Institute of Technology at Wright-Patterson Air Force Base, will become dean of engineering at South Dakota State College on 1 Mar. He succeeds H. M. Crothers, who had held the position for 30 years when he relinquished it last July. Crothers has continued on the State College staff as vice-president, a title he has held since 1947.

C. W. THORNTHWAITE, director of the Laboratory of Climatology, Sea-brook, N.J., is to deliver a series of free evening lectures at the Wagner Free Institute of Science, Philadelphia. The three lectures, which will be on the general subject of "Climate and the modern world," will be given on 12, 19, and 26 Apr.

LAURETTA BENDER, senior psychiatrist in charge of the children's service at Bellevue Hospital, New York, for 21 years, has been appointed principal research scientist in child psychiatry for the New York State Department of Mental Hygiene. The function of this new position will be to study adolescents and children and to serve as a consultant in child psychiatry to the department as a whole.

JOSEPH R. HAUN, formerly plant physiologist for weed control research with the Grasselli Chemicals Department of E. I. du Pont de Nemours and Company, Wilmington, Del., has been named director of the newly established weed control division of Insect Control and Research, Inc., Baltimore, Md., a firm of consulting entomologists. For the past 4 years his work with Du Pont has been concerned primarily with the development of the substituted urea herbicides.

ROBERT N. ISBELL, a colonel and a chemist with the Air Research and Development Command Headquarters, Baltimore, Md., has retired after more than 30 years of service. He was instrumental in developing from field military data a theory that electric energy might be used directly from controlled atomic reactions.

For the past 8 years Isbell has worked in the special weapons field in several different capacities: as chief of the radiological defense division of the Armed Forces Special Weapons Project at the Pentagon, and as chief of the weapons effects division of the Armed Forces Special Weapons Project; as director of nuclear applications and chief of the Atomic Operations Division at ARDC Headquarters; and, in 1948, as commanding officer of the Air Radiological Unit, Operation Sandstone, Eniwetok, Marshall Islands.

After serving in World War I, Isbell returned to civilian life and entered William Jewell College, where he received his B.A. degree in 1923. He attended Yale University from 1924 to 1926 and received his Ph.D. in chemistry from the University of Wisconsin in 1931. He has taught at Yale, Connecticut College of Pharmacy, and from 1931 to 1941 he was an associate professor of chemistry at Wake Forest College.

ROBERT S. HARRIS, professor of biochemistry of nutrition in the department of food technology at Massachusetts Institute of Technology, has been awarded the highest scientific honor that Cuba bestows—the Carlos J. Finlay award. ROBERT R. WILLIAMS of the Research Corporation, New York, shared honors with Harris for improving the nutrition of the Cuban people.

M. V. NEVITT, former head of the metallurgical engineering department at Virginia Polytechnic Institute, has resigned to join the staff of Argonne National Laboratory.



SAMUEL RENSHAW, professor of experimental psychology at Ohio State University, who served as academic director of the Navy Recognition Training School at Ohio State during World War II, will receive the Navy Distinguished Public Service award for his "outstanding contribution to the Navy in the research and development of the visual recognition training program."

Some 4000 officers were trained in the Renshaw method of visual perception, enabling them to identify approaching surface and air craft speedily. It has been estimated that approximately 285,000 preflight cadets benefited from this training, and officers trained in visual perception under Renshaw were aboard almost every Navy ship after 1943.

REED A. GRAY, plant physiologist for Merck and Company, Inc., has won the top Glycerine Research award of \$1000 and an honor plaque for research that showed that incorporating glycerine in streptomycin formulations increased the absorption of the antibiotic by plants and enhanced its effectiveness against the common bacterial blight of beans, a blight that takes an annual toll of crops estimated at \$6 million.

EUGENE P. KENNEDY, professor of biochemistry at the University of Chicago, won the \$300 second award for his study of the biosynthesis of phospholipids, which included the role of glycerine derivatives as precursors of these compounds. The third award of \$200 went to KARL H. LAUER, chemistry professor at the University of Alabama, for development of a process using slaked lime in glycerine-water solutions to convert sodium sulfate into caustic soda. Presentation of the awards was made at a luncheon in New York on 26 Jan. during the annual meeting of the Glycerine Producers' Association.

K. L. STELLMACHER, professor of mathematics at the University of Göttingen, Göttingen, Germany, will conduct a seminar between 2 and 23 May at the University of Maryland on the "Integration of general linear hyperbolic differential equations with application to Huygens' principle."

FREDERICK M. BECKET, pioneer metallurgist, has been honored by the establishment of the F. M. Becket Memorial award. The award, which is to be administered by the Electrochemical Society, is in the form of an annual scholarship aimed at interesting college students in the field of high-temperature electric furnace operations. The fund for the award was presented to the society by the Electro Metallurgical Company, a division of the Union Carbide and Carbon Corporation.

JOHN F. TAYLOR, chairman of the University of Louisville biochemistry department, is on leave of absence from that post to serve as visiting professor of biochemistry at the Physiological Institute of the University of Oslo, Oslo, Norway.

THOMAS B. NOLAN, since 1944 assistant director of the U.S. Geological Survey, has been named by President Eisenhower to succeed William E. Wrather as director of the Survey. The appointment awaits Senate approval.

JONATHAN E. RHOADS, professor of surgery and surgical research in the University of Pennsylvania School of Medicine and professor of surgery in the Graduate School of Medicine, was elected provost of the university on 17 Jan.

HAROLD C. UREY, distinguished service professor of chemistry at the University of Chicago, has been named Eastman professor at Oxford University, Oxford, England, for the 1956-57 academic year. The chair was founded in 1929 by George Eastman to send senior American scholars to lecture at Oxford. The Association of American Rhodes Scholars administers the fund and assists in making the annual selection.

Urey, who was the Nobel prize winner in chemistry in 1934, has specialized in the structure of atoms and molecules, thermodynamic properties of gases, and separation of isotopes. He discovered the hydrogen atom of atomic weight 2 and conducted research for the production of heavy water and U-235.

Recent Deaths

HENRY M. CRANE, New York, N.Y.; 81; consulting engineer to General Motors Corporation; a past president of the Society of Automotive Engineers who helped to prepare the standard American aeronautic safety code in 1926; 21 Jan.

JAMES E. DAVENPORT, New York, N.Y.; 68; retired vice president for engineering development and research of the American Locomotive Company; 24 Jan.

ADOLPH EICHHORN, Pearl River, N.Y.; 82; authority on animal husbandry; consultant on the veterinary medicine research staff of the Lederle Laboratories; 23 Jan.

RAPHAEL GINZBERG, Tomah, Wis.; 60; authority on diseases of the aged; chief of the geriatrics department of the Veterans Administration Hospital at Tomah, Wis.; 19 Jan.

ROYAL S. HAYNES, New York,

N.Y.; 78; retired specialist in pediatrics; former clinical professor of pediatrics at College of Physicians and Surgeons, Columbia University; 19 Jan.

ROBERT LOWY, Philadelphia, Pa.; 72; hydraulic engineer; special lecturer at the University of Pennsylvania and a former associate professor at Pennsylvania Military College; 21 Jan.

HARRY W. ORR, Stillwater, Okla.; 60; dean of the School of Veterinary Medicine of Oklahoma A. & M. College; 14 Jan.

ALEXANDER O. RANKINE, Hampton, England; 74; emeritus professor of physics at the Imperial College of Science and Technology; former chief physicist for the Anglo-Iranian Oil Company; World War II worker in the Petroleum Warfare Department on dissipation of fog on airfields; 19 Jan.

BLAKE VAN LEER, Atlanta, Ga.; 62; hydraulic engineer and president of the Georgia Institute of Technology; 23 Jan.

Education

■ **S. F. Posen**, president of Beltone Hearing Aid Company, Chicago, has given \$7000 to Northwestern University for a new soundproof hearing laboratory. The laboratory will make it possible to conduct research on various tests for the diagnosis of hearing impairments. The soundproof testing chamber is being constructed in the department of otolaryngology at the university's Medical Center in Chicago.

■ The 25th Venereal Disease Postgraduate Course for physicians sponsored by the University of Washington School of Medicine and the Public Health Service will be given in Seattle, Wash., 19-23 Mar. The course is designed to acquaint the practitioner with the latest developments in diagnosis, treatment, and management of the venereal diseases. The faculty for the course, which is accredited by the American Academy of General Practice, will be drawn from various universities, the Public Health Service, and from among authorities in the field.

No tuition will be charged. Applications for admission are to be sent to the University of Washington School of Medicine, Division of Postgraduate Medical Training, Harbor View Hospital Annex, 325 Ninth Ave., Seattle 4, Wash.

■ A new full-time program of graduate study in physics will be started next fall at Western Reserve University. This marks the first time in the history of the university that work leading to the Ph.D. degree in physics has been offered.

Although most of the research in physics will be carried out in the university's

physics laboratory, advanced graduate students in certain fields will be able to take advantage of the unusual research facilities in nuclear physics and chemistry at Argonne National Laboratory, Lemont, Ill., to complete their dissertations *in absentia*. Western Reserve has also announced an expanded program of studies in physics at the undergraduate level, including the regular offering of all advanced courses in physics every year.

■ The North Carolina State College School of Engineering has added a new degree to its curriculum—bachelor of metallurgical engineering.

Grants, Fellowships, and Awards

■ Negotiations for the extension of the Fulbright exchange program with India have just been completed. Application forms may be obtained from the Conference Board of Associate Research Councils, Committee on International Exchange of Persons, 2101 Constitution Ave. NW, Washington 25, D.C.

A booklet describing in detail the operation of the program will be sent out with forms. In view of the lateness of the announcement in relation to the beginning of the 1956-57 academic year in India, grantees will not be expected to arrive in India until July or August. To insure consideration applications should be postmarked *no later than 20 Feb.*

■ The 23rd annual program of Tau Beta Pi fellowships for graduate study in engineering have been announced. These include the Charles H. Spencer fellowship, the Louis Allis Company-Tau Beta Pi fellowship, and the Honeywell-Tau Beta Pi fellowship.

Each award is for \$1200, payable in ten monthly installments. For additional information, write to Paul H. Robbins, 1121 15 St. NW, Washington 5, D.C.

■ The Grass Foundation for research in neurophysiology will provide one or two fellowships for work at the Marine Biological Laboratory at Woods Hole, Mass., during the summer of 1956. The stipend will range from \$500 to \$1000, depending upon the financial needs of the candidate. Two candidates may apply jointly to work together with stipends of \$500 each. The fellowships are designed for young investigators in the predoctoral or early postdoctoral stage.

Applications may consist of a brief letter, preferably from some senior investigator who knows the candidate well, describing his qualifications and giving a brief account of his plans for research and how he would use the fellowship. Reprints of published work will also be helpful to the selection committee. Let-

ters and supporting material in triplicate should be sent to Dr. Robert S. Morison, Room 5500, 49 W. 49 St., New York 20. The closing date for applications is 1 Mar.

■ A Swedish-American exchange fellowship program to promote closer coordination in cancer research has been established by the American Cancer Society and the Swedish Anti-Cancer Society. An agreement was signed on 21 Jan. at the American group's headquarters in New York.

The arrangement provides for \$10,000 from the American organization and a like amount from the Swedish body to finance the program. Arne Tiselius, former president of the Swedish society's research board, and Mefford R. Runyon, executive vice president of the American society, signed the commitments. The project was initiated as the result of a recommendation by the Committee-on-Growth of the National Research Council.

■ A prize contest for engineers and designers for the best new applications of thin gage and/or high-precision tolerance stainless steel strip has been announced by the American Silver Company. Complete information and entry blanks may be obtained from the Chairman, Prize Awards Committee, American Silver Company, Flushing 54, N.Y. Thirty-one separate cash awards will be made in the contest, which closes at midnight, 30 May 1956. First prize is \$350.

In the Laboratories

■ The Atomic Energy Commission has announced approval of a program to encourage private industry to build and operate plants for the chemical processing of irradiated fuel elements from research and power reactors. Chemical processing plants perform the operations of recovering the fissionable and fertile materials present in the irradiated fuel elements for re-use, and of converting the radioactive fission products into disposable or usable forms. So far these operations are being performed only by Government-owned plants at various AEC sites.

To encourage industry to build its own plants for these purposes, the AEC will make available (i) commission technology in the field of chemical processing, and (ii) limited amounts of certain irradiated fuel materials from AEC reactors for processing by industry.

Firms must submit acceptable proposals to the commission at a date to be specified, probably approximately 18 months from now.

AEC facilities may be utilized by private firms for research and development and training in connection with the chemical processing field. The full costs of such utilization would be defrayed by the user.

In evaluating the proposals, the commission will take into consideration such factors as the advancement of chemical processing technology that will result from construction and operation of the proposed plant, reasonableness of prices, size, and start-up date of the commercial plant, and assurances against abandonment of the project.

Another criterion on which proposals will be evaluated is the manner in which the waste disposal problem will be handled. This criterion has been established in order to give industry the greatest possible incentive to reduce the cost and risks connected with this operation and to develop economical uses for the radioactive materials that are now generally regarded as waste products.

On the basis of its evaluation, the commission may select one or more of the proposals that it receives, or it may reject all of them. Further details about the program, together with certain classified information useful in the preparation of the proposals, will be made available to all interested and qualified companies.

■ The International Business Machines Corporation has established a new independent research organization. The new group will remain within the company's research and engineering department in Poughkeepsie, N.Y., but will be independent of its parent. It will be headed by Ralph L. Palmer, formerly I.B.M. director of engineering.

I.B.M. has also announced that a portion of the company's present engineering operations at Poughkeepsie will be reorganized into a product development laboratory. The new laboratory will be directed by Horace S. Beattie, former manager of the Poughkeepsie Engineering Laboratory.

Miscellaneous

■ The first issue of a new monthly bulletin, *Progress in Health Services*, has been issued by the Health Information Foundation, an organization that is sponsored by 200 companies in the drug, pharmaceutical, chemical and allied industries. This leaflet will interpret health statistics for the layman.

■ The Iranian Ministry of Education invites applications from qualified teachers to lecture in the provincial colleges of Tabriz, Shiraz, and Mashed, and at the University of Teheran. Openings are in

the following subjects: internal medicine, anatomic pathology, microbiology, serology, anatomic physiology, psychiatry and nervous diseases, chemical biology, preventive medicine and hygiene, parasitology, histology, microbiology, physics, chemistry, physiology, animal biology, and urology.

Maximum salaries in the colleges are approximately \$380 per month; at the university, \$625, with an additional allowance for rental. The Ministry of Education will also pay traveling expenses for the teachers and their families to and from Iran. Inquiries and applications should be addressed to the Iranian Embassy, Washington 8, D.C.

■ The University of Melbourne, Melbourne, Australia, has open a position as professor of agriculture. Closing date for receipt of applications in Australia is 15 Mar.

■ Drawings and models of the inventions of one of the colorful figures of the late 18th and early 19th centuries—Benjamin Thompson (Count Rumford)—are on display this month at Harvard University. Count Rumford devoted much of his research to the development of an efficient and simple coffee maker and is generally credited with being the first to produce a drip-type coffee pot. A description of this invention was carried in his essay "Of the excellent qualities of coffee" published in 1809.

Count Rumford's scientific curiosity covered a wide range: he conducted research in photosynthesis; he devoted a number of years to experiments that resulted in improvements in oil lamps; and he developed a portable cooking stove that freed housewives from their complete reliance on the fireplace.

■ N. R. Brewer, veterinarian at the University of Chicago, is interested in obtaining dogs with leukemia, dogs with symptoms of muscular dystrophy, dogs with certain types of cancer, dogs with anemia, diabetic dogs, dogs with pancreatic disease, and dogs with senile cataracts. These animals are needed to try specific treatments still in the research stage. They will be used for no other purpose. The University of Chicago will make arrangements for transportation, and there will be no charges involved for the treatment of any of these cases.

Ample funds are available for transporting dogs with symptoms of leukemia or muscular dystrophy from any part of the country. Limited funds are available to transport dogs with cancer, anemia, senile cataracts, diabetes and pancreatic disease. Those who wish to help this project should communicate with Brewer at 951 E. 58 St., Chicago 37, Ill.

Reports and Letters

Latent Learning in Earthworms

It has been suggested that any attempt to explain the complex kind of purposive action made possible by a highly developed central nervous system may be premature as long as we do not possess an adequate biological theory of the comparatively simpler kinds of purposive functioning (1). If, therefore, our purpose lies in understanding the functional relationship that exists between a complex nervous system and its environment, we must start by obtaining information about the behavior of nervous systems belonging to simpler organisms (2). The present study considered the problem of learning for a comparatively "simple" animal, the earthworm.

We selected the earthworm because it is one of the lowest invertebrates in which modifiability has been demonstrated and also to allow for subsequent experimentation attempting to show that higher nervous centers are necessary for the formation of cognitive maps—that is, without the supra-esophageal ganglion, latent learning is not possible, but not in the simpler situation of the reinforced type. In addition, we agree with those workers who have emphasized the importance of analytic studies of learning in very different animal types, for these investigations should reward us with important evidence and theoretical insight.

Investigations on the behavior of the earthworm date back to the classic paper of Darwin (3), who went so far as to ascribe "some degree of intelligence" to it. The studies of Yerkes (4) and von Heck (5) showed that earthworms are capable of learning a simple T-maze and that removal of the first five segments (cephalic ganglia) will not result in a loss of habit until the new segments have been regenerated. The work of Swartz (6) has shown that the behavior of the earthworm in a T-maze is random until training is started. Robinson (7) and Schmidt (8) have recently investigated learning in the same animal, with a view toward proving and disproving, respectively, the existence of a two-factor theory of learning.

The specific problem we investigated was that of latent learning. Our hypothesis was that the animals confined to the

maze for 20 hours prior to training with reinforcement would reach the criterion of seven successive correct responses (or more) out of ten trials in fewer runs than the animals that had had no previous maze experience.

Six earthworms (*Lumbricus terrestris* L.) were used, three in the latent (L) group and three in the reinforced (R) group. The T-maze was constructed as follows: The arms were constructed of glass tubing 25.4 cm long and 2 cm in diameter. The vertical arm was constructed so that it could fit into the horizontal arm, but it was detached therefrom. The position of the junction between the two arms was such that the horizontal arm was divided into a left arm of 10.1 cm and a right arm of 15.3 cm. These arms represented the negative and positive goals, respectively. At the end of the left arm (negative goal) very rough sandpaper was placed. This was followed by electrodes that delivered a shock of 1 volt. At the end of the right arm (positive goal) was a glass beaker filled with moist earth and moss. The beaker was covered with paper in order to reduce the light. The floor of the maze was lined with moist blotting paper, which was changed frequently to prevent tracking.

The following procedure was used. Group 1 (R): the animals were run with positive and negative reinforcement. Group 2 (L): the animals were allowed to run in a closed T-maze for a cumulative period of 20 hours. Negative or positive reinforcements were used during this period. At the end of this time, the animals were removed from the maze and run with positive and negative reinforcement. A correct choice was defined as turning to the right and going halfway down the right arm. The animals were run five times a day, when possible. Time between trials varied from 50 seconds to 20 minutes. A flashlight and a small camel's hair paint brush were used whenever necessary to start the animals moving when they halted for any length of time. After they had completed their runs in the maze, the animals were put in large Petri dishes, which were then put in the refrigerator, since the animals seemed to thrive best under these conditions.

The number of trials necessary for the animals in the R group to reach the required criterion was 37, 45, and 47, respectively. For the animals in the L group, the number of trials was 21, 22, and 23, respectively. The *t* test was employed to test the hypothesis that the mean number of trials required for learning by the R and L groups are equal against the alternative that the means are unequal. The *t* test substantiated (at the 0.01 confidence level) our initial hypothesis that the L group would learn more rapidly than the R group. An analysis of the complete data was done, utilizing the theory of stochastic processes. A Markov chain model was developed; its applicability to learning experiments has been discussed (9).

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3 August 1955

Fresh-water Sawfishes and Sharks in Netherlands New Guinea

A short notice on the occurrence of sharks and sawfishes in Lake Sentani, Netherlands New Guinea, has recently been published [*Science* 121, 759 (1955)]; about the same remarks can be found in the 18 February 1955 issue of the Australian newspaper *Daily Telegraph*. Because the data, which are said to be provided by H. Van Pel, fisheries officer for the South Pacific Commission, contain several errors, a rectification in this place seems advisable.

Lake Sentani is situated in the extreme northeastern part of Netherlands New Guinea; the eastern shore is within 10 miles southwest of Hollandia at an altitude of only about 250 feet above sea level. There is an effluent river of length about 40 miles that is, according to local (and rather unreliable) information, hardly passable in its upper reaches even for native proas (canoes). According to

current theory, which is sustained by considerable evidence, this lake has been formed out of an open bay through upheaval of this part of New Guinea by tectonic forces. Volcanism is not known to have occurred in this region.

During our recent visit to Netherlands New Guinea (October 1954–May 1955), we succeeded in obtaining from Lake Sentani two large sawfishes that measured 9½ and 11 feet. With the invaluable help of the Royal Netherlands Navy, we were able to ship these voluminous specimens to the Rijksmuseum van Natuurlijke Historie at Leiden. Because only small specimens or just saws have generally been collected and preserved, this was a very rare and valuable addition to our collections, much more remarkable than the occurrence of these specimens in fresh water.

After a provisional examination, we decided that both specimens seem to belong to *Pristis microdon* Latham, a species known to be at home in fresh water as well as in brackish and salt water. Specimens may occur far upstream in large rivers, and probably not only as occasional stragglers. For some species, there are strong indications of breeding in fresh water, a well-known habit of the specimens in Lake Nicaragua. For further data I refer to a previous rectification by A. W. C. T. Herre [*Science* 122, 417 (1955)].

Because we did not have the opportunity to investigate closely the conditions in the upper reaches of the effluent river, it still remains uncertain whether sawfishes may venture so far upstream as to reach Lake Sentani. However, although conditions may prevent the intrusion of specimens of the size we collected, it seems likely that small examples can make the journey, at least under favorable circumstances—for example, in the rainy season.

Reconsidering the adaptability to salt and fresh water, and the probable existence of a passable connection between Lake Sentani and the sea, the occurrence of sawfishes in this lake can easily be explained without using the theory of gradual upheaval and gradual replacement of salt water by fresh water. I should be more inclined to adopt this theory for the explanation of the occurrence of various other species that belong to essentially marine groups—for example, jacks (Carangidae)—which do not usually invade fresh water by free will. On the other hand, fishes from marine groups with little adaptability for fresh water were found—for example, in the Digoel River near Tanah Merah, about 450 miles from the sea, in a region where obviously no gradual upheaval and consecutive gradual replacement of previously salt water has taken place.

Small sawfishes are also said to occur

in the rivers near Genjem, about 15 miles west of Lake Sentani, but none could be obtained. Further specimens belonging to a different species were collected in the Digoel River near Tanah Merah.

Sharks were not collected in, or reported from, Lake Sentani, and they probably do not exist there. The only fresh-water sharks we obtained were found in Lake Jamoer, a rather large and almost circular lake (diameter approximately 5 miles) situated on the narrow neck of the Vogelkop Peninsula (longitude 135°E). The altitude is about 200 feet. The physical characteristics of the effluent river Omba are insufficiently known, which makes it at present impossible to establish with certainty whether the species is landlocked. The collected examples measure up to 5 feet and, according to a superficial examination, are closely related to the landlocked shark from Lake Nicaragua and to the Ganges shark.

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18 November 1955

Inhibition of Audiogenic Seizures by Carbon Dioxide

In previous publications, it has been shown that the acid-base balance plays a role in the susceptibility of rats and mice to audiogenic seizure (1, 2). Acidosis, as determined by blood pH measurements (1) was produced by a carbonic anhydrase inhibitor (acetazoleamide). This effect was correlated with diminished seizure susceptibility. Alkalosis, produced by injections of subcutaneous doses of sodium bicarbonate, conversely increased the number of seizures. Presumably, the observed inhibition of audiogenic seizures was due to the accumulation of carbon dioxide and the presence of acidosis in the animals (3). However, since acetazoleamide is a drug with rather diffuse actions, it seemed desirable to determine the effect of carbon dioxide without any injected agent on the susceptibility of rats to audiogenic seizures.

The audiogenic seizure apparatus used has been described elsewhere (doorbell method, 1). A rubber tubing inlet was provided in the lid of the seizure chamber to allow the introduction of gases. Mixtures of gases prepared consisted of carbon dioxide and air, with enough oxygen added to raise the oxygen concentration to between 20 and 21 percent. The gas delivery rate into the seizure chamber was approximately 8 lit/min.

Rats were placed in the seizure chamber 2 minutes before the bell was turned

Table 1. Inhibition of audiogenic seizures by various levels of carbon dioxide. There were 24 trials in each series.

CO ₂ treatment (%)	Seizures	Percentage of seizures (CO ₂ rats/controls)
2.09	14	77.7
Controls	18	
4.79	8	42.1
Controls	19	
8.91	2	11.8
Controls	17	
13.55	0	0
Controls	20	

on, and the various mixtures of CO₂ were run into the chamber during this time. Actual CO₂ levels at the end of 2 minutes in the seizure chamber were determined by the Haldane method (4). Stimulation time was 1.5 minutes, with CO₂ administration being continued throughout.

The rats were males of the Wistar strain weighing 200 to 400 g.

All rats used in this study were originally chosen for their seizure susceptibility. The rats were divided into two groups for testing the effects of the individual levels of CO₂. One group received CO₂ at a given level on the first trial, and the other group served as controls; air was delivered into the chamber for an equal period of time. Five days later, the groups were reversed for the second trial, the former controls receiving CO₂ at the same level and the former CO₂ rats acting as controls.

A seizure was taken as a convulsion, usually clonic-tonic. If a convulsion did not occur, a seizure was not counted.

Table 1 shows the gas level-response data that were obtained by administering various concentrations of CO₂ to seizure-susceptible rats and testing for seizures after 2 minutes. The CO₂ levels represent actual concentrations in the seizure chamber as determined by Haldane analysis. The various levels from top to bottom were obtained by running 2.5, 5, 10, and 20 percent CO₂ into the seizure chamber for the specified time interval. For the control rats, it was found that 0.235 percent CO₂ was present in the seizure chamber. It is apparent that CO₂ levels as low as 2.09 percent exhibit a slight effect and that 13.55 percent CO₂ resulted in complete inhibition of seizures. It is interesting to note that 8.91 percent CO₂ resulted in exactly the same values as injected acetazoleamide at 200 mg/kg; the latter values were obtained from a previous study (1).

In other studies on the effect of acid-

base balance on the excitability of the central nervous system, convulsions were generally induced by drugs or electric shock. In some cases, anesthetized preparations were used (5). The present work and previous studies on audiogenic seizures (1, 2) confirm that CO_2 accumulation tends to depress central nervous system excitability and show that this is true in the intact animal.

It has been postulated that the anticonvulsant action of acetazolamide is due to direct brain carbonic anhydrase inhibition (6). There is little doubt that acetazolamide does inhibit brain carbonic anhydrase, however, in view of increasing evidence suggesting respiratory acidosis resulting from blood carbonic anhydrase inhibition after administration of large doses of acetazolamide (3, 7); it seems premature to ascribe the anticonvulsant effect of acetazolamide to such a localized action.

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25 August 1955

Use of Glycine in Bovine Semen Extenders Stored at 5° and -78°C

The survival time of bovine spermatozoa has been increased with the use of a 3-percent glycine extender beyond the time, obtained with use of a 3.2 percent sodium citrate extender when stored at 4°C (1). This advantage of glycine over sodium citrate was believed to be due to the low electrolyte content and to the maintenance of the functional integrity of the sperm cells. Evidence has been presented to indicate that amino acids play an important role in the physiology of the sex organs (2). Further evidence has been presented to demonstrate that certain amino acids increase the life span of sea urchin spermatozoa, but that they are not used metabolically. It has been

Table 1. Influence of glycine-yolk and citrate-yolk extenders on the motility of bovine semen stored for 7 days at -78°C.

Extender	Ejaculates (No.)	Avg. motility (%)
3% glycine	10	50.8 ± 5.36
2.05% glycine	10	49.7 ± 5.66
2.9% citrate	10	50.7 ± 6.16

found that glycine extends the viability of fowl spermatozoa (3).

Gassner and Hopwood (4) have reported that the amino acids found in bovine semen, in order of apparent concentration, are glutamic acid, alanine, glycine, serine, and aspartic acid. The concentration of any of the five amino acids is about the same in both plasma and whole semen.

Tyler and Rothschild (2) observed that when whole semen was incubated for 3 hours to permit metabolism of fructose by spermatozoa, none of the amino acids were utilized. The purpose of amino acids in semen appears to be other than for metabolic functions. Since they are amphoteric in reaction, they may be a part of the natural buffer system. Glycine was selected as the amino acid to be used in this study because of its natural occurrence in semen and because of the indication of its possible use that was given by other workers (1).

Three-percent glycine in double-distilled water is not isotonic to bovine semen. Freezing-point determinations in this laboratory indicate that 2.05-percent glycine in double-distilled water with added antibiotics is isotonic to semen. It was decided to test the 2.05-percent and the 3-percent levels of glycine against 2.94-percent sodium citrate (dihydrate), which would serve as a control, since it has been in common use in bovine semen extenders for many years.

The semen was collected from dairy bulls in an artificial vagina. It was transferred immediately to a test tube that was stoppered to prevent contamination. The semen was then divided into three equal portions and extended with the following: (i) an extender made up of 50 percent egg yolk and 50 percent by volume

of 2.94-percent sodium citrate (dihydrate) solution; (ii) an extender made up of 50 percent egg yolk and 50 percent by volume of 3-percent glycine solution; and (iii) an extender made up of 50 percent egg yolk and 50 percent by volume of 2.05-percent glycine solution. The rate of extension was 1 part bovine semen to 20 parts of extender.

The antibiotic levels used were 0.2 g streptomycin and 0.06 g penicillin per 100 ml extender. The extended semen was then cooled in a refrigerator at 5°C for 5 hours. A small sample was then taken for storage at 5°C. The remaining portions were extended by adding at a rate of 1 to 1 a solution consisting of (i) 16 percent glycerol by volume in 2.9-percent sodium citrate (dihydrate) solution; (ii) 16 percent glycerol in 3-percent glycine solution; and (iii) 16 percent glycerol in 2.05-percent glycine solution, respectively. The final concentrations of the components of the three extenders were as follows: (i) 67 ml of 2.9-percent sodium citrate (dihydrate) solution, 25 ml of egg yolk, and 8 ml of glycerol; (ii) 67 ml of 3-percent glycine solution, 25 ml of egg yolk, and 8 ml of glycerol; (iii) 67 ml of 2.05-percent glycine solution, 25 ml of egg yolk, and 8 ml of glycerol.

The extended semen was then sealed in glass vials and equilibrated for 18 hours at 5°C. It was then frozen in a bath containing acetone and Dry Ice. The rate of freezing was 1°/min from 5° to -15°C and 3 to 4°/min from -15° to -72°C. The samples were transferred to a storage cabinet containing Dry Ice in methanol and stored at -78°C. The samples were thawed on the seventh day and the percentage of motile spermatozoa was observed. The results of this trial are presented in Table 1. An analysis of variance indicated that the differences observed were not significant. The motility observations on the extended semen stored at 5°C are presented in Table 2. After 4 days of storage, there appeared to be little difference between extenders. After 6 days of storage, the glycine-yolk extenders appeared to give better results than the citrate-yolk extenders. The pH observations indicate that glycine does not buffer the extended semen as well as sodium citrate.

Table 2. Influence of glycine-yolk and citrate-yolk extenders on the motility and pH of bovine semen stored at 5°C.

Storage (days)	Ejaculates (No.)	Avg. motility (%)			Storage (days)	pH of extended semen		
		2.05% glycine	3% glycine	2.9% citrate		2.05% glycine	3% glycine	2.9% citrate
2	10	64.4	65.4	63.4	1	6.45	6.40	6.78
4	10	58.4	59.4	58.7	5	6.32	6.32	6.73
6	10	48.4	45.0	40.0				

We conclude that glycine-yolk extenders are equally as good as citrate-yolk extenders under the conditions of this experiment.

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22 August 1955

Absence of Indoleacetic Acid in the Apple

Indoleacetic acid (IAA) is now generally regarded as an auxin of widespread and perhaps universal occurrence in plants. The evidence for this view is based largely on the occurrence on paper chromatograms of plant extracts of an acidic substance that has an R_f value similar to that of synthetic IAA, which is active in promoting cell extension growth in coleoptile sections and which may give characteristic, although not highly specific, color reactions with Salkowski and Ehrlich reagents.

In the acid fraction of ether extracts of both fresh and dried apple seeds, pollen, fruits, and leaves we have found an auxin with an R_f value in butanol-ammonia of 0.30 to 0.45, which is close to that of IAA (R_f 0.25 to 0.40). This auxin, which seems to be the most characteristic and widely distributed auxin in the apple, has been referred to in a previous publication as *Malus auxin 2* (1). Hancock and Barlow (2) also found such an auxin in the acid fractions of extracts of young apple leaves and concluded that it was probably IAA. The failure of this auxin to give the characteristic color reactions of IAA even when, according to its biological activity, it was present in sufficient amount, led us to investigate more critically the question of its identity. On the basis of evidence presented here, we conclude that this auxin is not identical with IAA; neither have we obtained, in the course of these investigations, any evidence that IAA occurs in apple tissue.

The absence of typical IAA color reactions is not the result of the presence on the chromatogram of inhibitors, because authentic IAA cochromatographed with the unknown yielded typical IAA color reactions.

The R_f of biological activity in these chromatograms was usually somewhat

greater than that of authentic IAA (Fig. 1). A critical comparison of R_f values was made by eluting material from the center of the active spot and rechromatographing this in butanol-water-ammonia. To an adjacent spot of the same extract, 1 μ g of IAA was added; after development, this chromatogram was tested with Salkowski reagent. It would appear from this experiment that *Malus auxin 2* in this solvent has an R_f value approximately 10 percent higher than that of IAA (Fig. 2). It should be noted that a difference in R_f value of this magnitude would scarcely have been detected by the technique of Hancock and Barlow (2), who divided their chromatogram strips into only ten portions preparatory to biological assay.

Other solvents such as distilled water, which is recommended by Sen and Leopold (3), give more definite separation of the unknown auxin and IAA. *Malus auxin 2* was eluted from butanol chromatograms with 90-percent ethanol. The eluate was rechromatographed with water as a developing solvent. The R_f of authentic IAA was 0.95 and that of *Malus auxin 2* was 0.4 to 0.6 (Fig. 3). The double peak given by the unknown auxin on these water chromatograms is due to an inhibitor with approximately the same R_f value, which causes a depression of coleoptile extension in the center of the auxin spot. In addition to this inhibitor, which shows up as a yellow spot after it is sprayed with Ehrlich's reagent, two further compounds separated out on these chromatograms. One of these, at R_f 0.25 to 0.35, gave a pink Ehrlich reaction, while the other could be detected by its bright blue fluorescence under ultraviolet light; neither appeared to be biologically active. No Ehrlich reaction was obtained

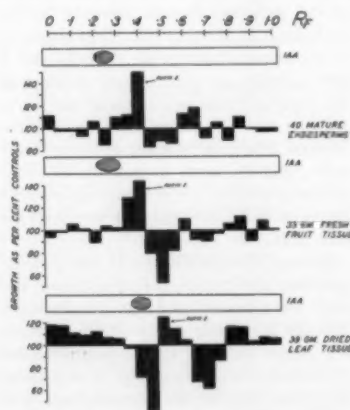


Fig. 1. Chromatograms of the acid fraction of ether extracts of various apple tissues, developed in butanol-ammonia and assayed in the wheat coleoptile section test. The R_f of IAA in each test, as determined by the Ehrlich color reaction, is shown.

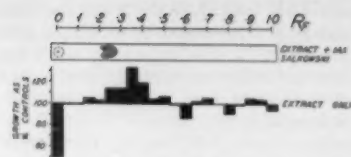


Fig. 2. Auxin 2, eluted from chromatogram and rechromatographed in butanol-ammonia, with and without added IAA. Auxin 2 was detected by assay in the wheat coleoptile section test and IAA was detected by Salkowski reaction.

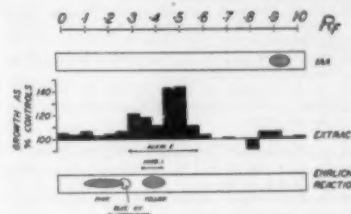


Fig. 3. Auxin 2, eluted from butanol chromatogram of leaf extract and rechromatographed in water, with and without added IAA. Chromatograms tested with Ehrlich's reagent and in the wheat coleoptile section test. A clear separation of IAA and auxin 2 is shown.

in a position corresponding to the unknown auxin.

Besides its activity in promoting cell elongation, this auxin is active in stimulating root formation on the hypocotyls of *Phaseolus vulgaris* and in delaying the abscission of debladed petioles of *Coleus*, even though, like IAA, it appears to be inactive in the tomato ovary test (4). Its failure to give a color reaction with Ehrlich's reagent, even when it is present in amounts equivalent to 0.3 μ g of IAA, suggests that it may not even be an indole compound, but this cannot be stated definitely on the basis of the present evidence. The absence of IAA from the apple is particularly interesting in view of its apparent widespread distribution in other plants, including at least one other member of the Rosaceae (5).

Malus auxin 2 appears to be the only auxin present in the flesh of the apple; in the seeds and leaves, two other unknown acid auxins occur in addition to at least one neutral auxin (1). Teubner (6) claims that he has identified the neutral auxin of the apple endosperm as ethyl indoleacetate. However, his identification is based only on a similarity in R_f values in butanol-ammonia and on color reactions, both of which are unreliable when one is dealing with neutral auxins. In view of the apparent absence of IAA, it would seem that Teubner's claim that he has found the ethyl ester should be critically reexamined. His further assumption

that this neutral auxin is the one that Luckwill (7) found to be correlated with fruit drop is also untenable, for it has been previously established that the anti-drop auxin of the apple is an acidic substance (8).

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25 August 1955

Some Comments on "Temperature Profiles Throughout Cigarettes, Cigars, and Pipes"

Recently C. R. Greene (1) reported that he had obtained temperatures of cigarette "hot spots"—presumably the coal temperature—that varied between 610° and 740°C and smoke temperatures entering the mouth that varied from 50° to 70°C. Coal temperatures of cigars, he stated, range from 600° to 660°C, with temperatures of the smoke that enters the mouth ranging from 40° to 60°C. He reported "hot spot" temperatures of aromatic pipe tobaccos between 540° and 590°C, while untreated, non-aromatic tobaccos had coal temperatures of 420° to 450°C. Temperatures of the smoke at the bottom of the pipe bowl were as low as 30°C with some tobaccos and ranged up to 50°C. No mention was made of the technique of smoking or of the length of the butt of the cigarette or cigar that remained when he determined, respectively, the coal temperature or the smoke temperature. Obviously, in the case of smoke temperatures, the technique of smoking and the distance that the smoke travels from the coal before it reaches the thermocouple (or mouth) is of great significance.

There is little in the literature regarding the temperature of the coal of cigarettes, cigars, and pipes or the main-stream smoke temperatures. In 1936 Bogen (2) reported that the temperature of inhaled cigarette smoke changed very little from that of room air during the

burning of the first quarter of the cigarette, but that there was a gradual rise with successive puffs until about one-half of the cigarette had been consumed, at which point the temperature reached that of the human body.

Mulinos and Cockrill (3), using an intermittent suction-type smoker, reported that there was no change in main-stream cigarette smoke temperatures until after 5 cm of the cigarette had been consumed and that the temperature of the smoke did not exceed body temperature until a butt length of about 1 cm remained.

McNally (4), using thermometers placed in the smoke stream, reported that smoke temperatures for the first 3½ cm of the cigarette remained at about 27°C. This temperature gradually rises to 52°C when the cigarette is smoked to within 0.5 cm of the end. McNally also pointed out that rapidity of smoking is a very important factor, since cigarettes that are smoked in a very short period of time show much higher smoke temperatures, particularly when butt lengths become shorter than 2 cm.

In this laboratory the temperature of main-stream cigarette smoke and coal temperatures have been measured under conditions simulating human smoking. The smoking technique used consists of taking one 35-ml puff of 2-second duration once each minute. This technique has become standard practice in the industry and is currently used in most other laboratories where serious investigations of the composition of smoke are being undertaken.

Measurements of cigarette smoke temperatures were accomplished by means of thermocouples made from No. 40 B & S gage iron and constantan wire connected to a recording pyrometer. The thermocouple was drawn into the middle of the cigarette 35 mm from the end to be lighted by piercing it at right angles to its longitudinal axis with a needle. After the thermocouple junction was in place in the cigarette, the holes around the wires were sealed with a small amount of Duco cement. Marks were made at 1-mm intervals along the seam so that the distance of the coal from the thermocouple could be estimated. The ambient temperature was 23°C.

Several determinations of smoke temperature at various distances from the coal were made, and the results were plotted. A smooth curve drawn through the points showed smoke temperatures as follows: at a distance of 35 mm from the coal, the smoke temperature was 23°C; at 30 mm, 26°C; at 23 mm, 37°C; at 20 mm, 49°C; at 10 mm, 73°C; and at 3½ mm, 103°C. Thus, it is seen that, when cigarettes are smoked under conditions simulating human smoking, the temperatures of smoke that would enter the mouth do not exceed body tempera-

ture unless the cigarette is burned to a shorter butt length than 23 mm. In our experience, not one cigarette smoker in 1000 smokes to a butt of length less than 23 mm. Hence, the smoke entering the mouth almost never exceeds body temperature.

Cigarette coal temperatures were measured by thermocouples made from No. 40 B & S gage platinum and platinum-10-percent rhodium wires brazed to make the smallest durable junction. The thermocouple was positioned across the longitudinal axis of the cigarette 15 mm from the end to be lighted. Temperature measurements were made by means of a Leeds and Northrop potentiometer. In order to obtain maximum coal temperatures during puffing, puffs were taken as rapidly as resulting temperatures could be accurately measured by the potentiometer. Using this technique, temperatures of the cigarette coal during puffing averaged about 774°C, while free-burning (not puffing) coal temperatures averaged about 746°C. Since smoke temperatures at a distance of 3½ mm from the coal were about 103°C and maximum coal temperatures during puffing were of the order of 774°C, it is seen that the smoke had cooled 671°C while traveling a distance of only 3½ mm. The time that it takes the smoke to travel this distance is of the order of 0.01 second, which gives some indication of the rapid rate of cooling.

In the case of pipe smoking, the usual range of temperatures of smoke is of the order of 34° to 41°C. The technique used for studying pipe smoke was considerably different from that used for cigarettes. Pipe smokers take several small puffs in very short periods of time and then delay for a much longer period before puffing again. The temperatures reported here were obtained by puffing eight or nine times per minute, taking a 25-ml puff of 1-second duration. Coal temperatures in the pipe ranged from 704° to 871°C. No measurements of cigar smoke and coal temperatures have been made in this laboratory.

Greene postulates that the "wide temperature difference between cigarettes and pipes must be due, in part, to the potassium chlorate used to treat cigarette tobacco in order to insure even and continued burning." The assertion that oxidizing agents such as potassium chlorate are used to control the burning of cigarette tobacco has appeared in the literature at intervals for many years. Such statements, unsupported by facts, tend to perpetuate misinformation. To correct this misapprehension, it may be stated categorically that oxidizing agents are not added by any of the leading tobacco manufacturers.

Greene's conclusion that cigarettes are more carcinogenic than pipes is based on

the premise that cigarette coal temperatures are about 300°C higher than the coal temperatures in pipes. The results obtained in this laboratory indicate, if anything, that the burning coal in the pipe is at a more elevated temperature than that of the cigarette. We are certainly not qualified to attempt to relate combustion temperatures and carcinogenicity. Furthermore, we are not aware that it has been established that cigarette smoke is carcinogenic. Many reputable investigators have been unable to produce cancer in animals by means of cigarette smoke tars, and no one has yet demonstrated that tobacco smoke is carcinogenic to human beings.

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4 November 1955

E. S. Harlow has criticized the incompleteness of my brief report and points out the fact that the tobacco industry has standardized techniques that simulate human smoking. As previously indicated [*Science* 122, 514 (1955)], I am a petroleum chemist who was led into this digression by curiosity. In measuring the temperatures that I reported, the individual who donated the particular cigarette, cigar, or pipe was kind enough to smoke it in his usual manner while the temperatures were being measured. This uncontrolled method of determining these temperatures may, in some respects, be responsible for the differences in smoke temperatures found in the apparatus that simulates human smoking and those found in my cursory examination.

I certainly did not intend to perpetuate a misapprehension by suggesting that cigarettes may have a higher coal temperature because of the use of an oxidizing agent, such as potassium chlorate. However, I have observed that certain brands of cigarettes, when placed in an aqueous solution of potassium iodide, will produce a titratable amount of iodine. Furthermore, cigarettes, unlike cigars or pipes, will burn to extinction once they are lit.

The basic point that I would like to reemphasize in the light of Harlow's informative letter concerns the possible chemistry involved in tobacco combustion. As Harlow points out, the temperature a few millimeters from the glowing coal is comparatively quite cold. Therefore, in smoking, tobacco is very rapidly heated to extremely high temperatures. When pure organic compounds are sub-

jected to such treatment in the laboratory, a profusion of very reactive free radicals results. It would, therefore, seem reasonable to postulate that the smoking of tobacco will result in the formation of free radicals. It should be comparatively easy to identify any free radicals in the tobacco smoke by using techniques such as paramagnetic resonance absorption.

Although it is true, as Harlow points out, that recent, well-publicized results of the statistical groups within the American Medical Association do not conclusively prove a relationship between cigarette smoking and lung cancer, one cannot, with true scientific impartiality, ignore these findings. If one accepts the postulate that there may be a possible relationship between cigarette smoking and lung cancer, we must then find a verifiable hypothesis to explain such a relationship. It was from this standpoint that the proposal was made that the differences in coal temperatures between cigarettes and pipes may lead to a difference in the concentration of volatile radicals liberated during the burning of tobacco. As Harlow's results show, the conditions in burning tobacco are those of thermal cracking. The transitory product of thermal cracking is free radicals. There is an overwhelming accumulation of evidence in the scientific literature that free radicals and compounds that readily yield free radicals are carcinogenic. In testing any hypothesis that would relate cigarette smoking to lung cancer, it would, therefore, appear to be of interest to examine cigarette smoke for the presence of free radicals or free-radical precursors.

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6 January 1956

Virus of Bats Antigenically Related to St. Louis Encephalitis

A bat survey was begun early in 1954 at the Brooke Army Medical Center, Fort Sam Houston, Tex., because of a malady afflicting the bat colony. An encephalitis was apparent among these animals as manifested by deranged behavior, muscular tremors, urine incontinence, and parietic manifestations. Hundreds of deaths were recorded.

The purpose of this article is to report that, on separate occasions, in addition to the isolation of the virus of rabies from bats, a virus antigenically related to St. Louis encephalitis was recovered.

At first, the bat encephalitic manifestations were attributed to the effects of an intensified DDT program in the area. Chemical analyses of 3.62 g of omentum collected from 93 bats revealed a total of 184 µg of DDT, the equivalent of 50

ppm (1). Studies conducted by Hayes (2) on the relationship between dosage of DDT and its storage in adipose tissue for several species of animals that were fed daily doses of the compound indicate that the storage level we found in bats of 50 ppm of DDT would require a DDT dosage level of about 0.08 mg/kg a day. Rats can withstand daily doses of DDT at more than 100 times this level. It would not be expected, on the basis of results with other species, that any harmful effects would result in bats from this amount of DDT exposure.

Bacteriological studies of brain, liver, and spleen employing differential media for the isolation of aerobic and anaerobic bacteria were essentially negative.

From the brain tissue of 335 necropsied bats, nine virus isolates were obtained in white Swiss mice (3, 4). These isolates were identified as the virus of rabies by the standard intracerebral neutralization technique. Tests with infected mouse brain tissue against known rabies-immune horse serum demonstrated that the immune serum neutralized both its homologous virus and the newly isolated bat strains.

In addition to confirmed rabies isolations, five other viral agents were recovered from the salivary glands of encephalitic bats in white Swiss mice. The bat salivary gland virus has an incubation period of 5 to 6 days intracerebrally in mice. With the exception of mice and bats, host susceptibility studies including rabbits, hamsters, guinea pigs, and goats were negative.

Reciprocal complement-fixation tests with known neurotropic virus antigens and antisera and with antigens and antisera to the bat salivary gland agent suggest that the bat virus shares some antigen common to St. Louis encephalitis virus (Hubbard strain). Thus, specific St. Louis encephalitis guinea pig antisera consistently fix complement with bat antigens. This fixation is of low order and is not reciprocal, for high-titered bat antisera will not fix complement with St. Louis encephalitis antigens. No relationship to any other arthropod-borne virus has been demonstrated by complement-fixation tests.

The bat virus is partially neutralized by potent hyperimmune St. Louis encephalitis rabbit serum. There was no evidence of reciprocal activity. Antisera of western equine encephalomyelitis, eastern equine encephalomyelitis, lymphocytic choriomeningitis, encephalomyocarditis, and rabies exhibited no neutralizing effect against the bat virus.

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25 August 1955

Quantitative Microinjection of Mosquitoes

A method for obtaining oocysts of the malaria parasite free from the mosquito stomach wall was sought as a further step toward the *in vitro* studies of the development of oocysts of *Plasmodium relictum* in *Culex tarsalis* (1). Following Weathersby's results (2) in obtaining infection of the mosquito (*Aedes aegypti*) with oocysts unattached to the stomach wall by injecting blood infected with the parasite (*Plasmodium gallinaceum*) into the hemocoel of the insect, an attempt was made to use this technique to obtain free oocysts (3).

The injection setup consisted of two parts, the injector and the insect holder (Fig. 1). Adapted from the "braking" pipette of Holter (4), the injector was made of two components: (i) a needle drawn from glass tubing forming a spindle with a capillary at each end and (ii) a glass tubing jacket, tapered at one end, into which the spindle was sealed and made airtight with Duco cement (Fig. 2, top). For injection, the injector was clamped firmly to a stand in a horizontal position and fastened to a rubber bulb that was provided with a check valve. Solutions to be injected were brought in touch with the point of the needle; the spindle then filled itself through capillary action. Known quantities of solution were obtained by using accurately calibrated spindles of different sizes.

The insect holder was a device similar to that of Wallis (5). It was made of glass tubing with a tapering end. The insect was held on the opening of this end by suction (Fig. 2, top). Successful attachment depended on a suitable size of the opening and the shape of the contact area of the insect. An opening with a curved surface could be ground to suit the particular need. The holder was mounted on a clamp that was attached to a mechanical stage by a spring-loaded lever. A screw in control of the lever provided vertical movement, as is shown in Fig. 1. Thus, within a sufficient range, the holder could be fitted to any position demanded.

The injection was carried out by setting the needle point of the injector in the center of the field of the dissecting

microscope and then bringing the insect, impelled by the holder, to the needle. When the needle had pierced the body wall of the insect, pressure was maintained on the rubber bulb until the insect was drawn away from the needle in order to avoid backflow of the injected material.

The site selected for injection was the base of the metacoxa (Fig. 2, top); and the age of the mosquitoes used was not less than 3 days, for younger ones did not stand injection well. To immobilize the mosquitoes, a combination of carbon dioxide and cold was found satisfactory. The mosquitoes were first knocked down by CO₂, separated into small lots, and then kept inactive in an ice bath. A continuous CO₂ chamber in which the injection was carried out was found to be very convenient but was abandoned because of the possible effect on the solution to be injected.

Before injecting the parasitized blood of the canary, the technique of injection

and the effect of the anticoagulants were tried on both sexes of the mosquitoes. The anticoagulants used were either sodium citrate or heparin in normal saline. At times, glucose was added to the saline-anticoagulant mixture as a possible essential food supplement for the activities of the parasites. Doses of 0.61 mg (comparable to the amount of blood in a fully engorged mosquito) each were injected into the females. Almost 100-percent survival was obtained regularly. Needles varying in diameter from 10 to 90 μ were equally safe, and in one experiment, a needle 300 μ in diameter was used on 13 females, nine of which survived for many days.

Repeated injections were also tried on a total of 21 females in two separate trials. These were fully injected three times on alternate days with a needle 40 μ in diameter, and 19 were still surviving on the third day following the last injection.

However, the males were less hardy,

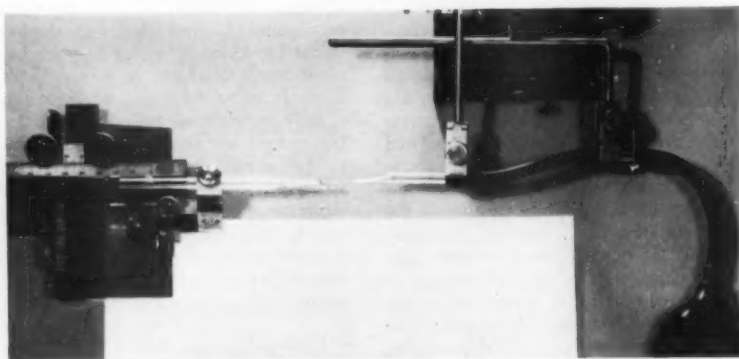


Fig. 1. Insect holder and injector.

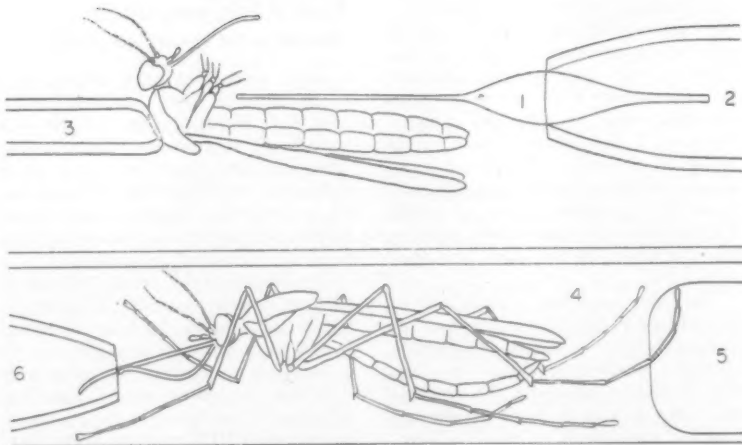


Fig. 2. (Top) Injection of mosquito; (bottom) forced feeding of mosquito. (1) Needle, (2) jacket, (3) insect holder, (4) glass tubing, (5) plastic rod, (6) micropipette.

and about 40 percent of them died on the third day after being injected with 0.41 mg of either heparinized or citrated saline solution. The needle diameter was about 40 μ .

For injecting parasitized blood, canary blood at the peak of infection was drawn. Either heparin, citrate, or additional glucose was added, or the blood was subjected to centrifugation and washed with normal saline; then it was injected into the mosquitoes. When saline-anticoagulant solution was used, the blood was diluted by one-fourth of its volume. However, when the blood cells were washed with normal saline without including an anticoagulant, the mixture was centrifuged, the supernatant was drawn away, and the original volume of the blood was restored with saline.

By the end of 2 weeks—the normal time for maturity of oocysts in the laboratory—the injected mosquitoes were dissected and examined for oocysts and sporozoites. The total number of the females surviving and examined was 73 out of 322 injected (23 percent), and of the males, five out of 118 (4 percent). In all cases the results were negative. Since the main purpose of this experiment was to obtain young oocysts free from the stomach wall of the mosquito for *in vitro* culture studies, the possible presence of oocysts and sporozoites was neither searched for histologically, nor was their presence tested by permitting the mosquitoes to bite a canary as Weathersby did in his unique experiments (2, 6).

To test the viability of the parasites, mosquitoes were fed artificially with a micropipette (7) that contained some of the sample of blood employed for injections (Fig. 2, bottom). Practically all the females that took the blood, heparinized or citrated, developed oocysts and sporozoites in a normal course. Viable eggs were laid and normal adults emerged in due time. A few males were also induced to feed, but none of them lived long enough to be dissected for the examination for any possible infection (8).

These techniques may well serve advantageously for research on mosquitoes carrying viruses, such as the recent work of McLean (9).

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10 FEBRUARY 1956

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8 August 1955

Ethylene Oxide for Sterilizing Diets

Hawk and Mickelsen (1) showed that treatment of diets for rats with ethylene oxide produced deleterious effects. Thiamine was almost completely destroyed, but this was not the sole effect, for supplementation with either thiamine or a complete vitamin mixture did not significantly stimulate growth.

At our laboratory, ethylene oxide in both the liquid and the gaseous (2) forms has been successfully used to sterilize liver brei, a chemically defined diet (3), and various mixtures of these two foods that were used to rear the larvae of the dipterous parasite *Pseudosarcophaga affinis* (Fall.) (4).

Liquid ethylene oxide was used to sterilize the liver brei. Working in a cold room (1°C) with thoroughly chilled materials, we pipetted 1 ml of ethylene oxide into 250-ml Florence flasks containing 100 g of liver brei. After 2 hr in the cold room, the flasks were allowed to reach room temperature in a well-ventilated area. They were then placed in an incubator at 37°C for 24 hours to remove toxic traces of ethylene oxide. Fifty larvae were reared individually on aliquots of the sterile brei. They thrived.

Gaseous ethylene oxide was used to sterilize 66 chemically defined diets containing various amounts of liver. Forty milliliters of each diet, without added vitamins, were placed in 250-ml Florence flasks and sterilized. A low-pressure supply of gas was obtained by partially inflating a valveless inner tube. The gas in the inner tube was used immediately to reduce the time of contact with the rubber. The flasks containing the material to be sterilized were put in a 250-mm vacuum desiccator, and the pressure was reduced 25 to 26 in.-Hg below ambient. The gas was admitted from the inner tube until the pressure in the desiccator was within 5 in.-Hg of the ambient pressure. The cycle of evacuation and admission of carboxide was repeated once.

The material was allowed to remain in the atmosphere of ethylene oxide for at least 24 hours; and then the desiccator was flushed with air three or four times. The diets were allowed to stand at room temperature for approximately 24 hours before use. The vitamins, in solution, were then filtered through a bacteriologi-

cal filter and added to the medium under aseptic conditions. In all, 3250 larvae were reared individually on diets that had been sterilized in this manner, and only four were contaminated. On media that contained no liver, whether sterilized by autoclaving or by ethylene oxide, 50 percent of the larvae reached the third instar in about 5 days. Ethylene oxide, therefore, did not have a deleterious effect on the diet.

The difference between these results and those of Hawk and Mickelsen (1) may be a result of differences between parasitic larvae and rats, but several additional reasons can be suggested. The vitamins of the chemically defined diets were not exposed to ethylene oxide. The diets were treated in a buffered solution, not in the dry state (as the rat diet was treated), and carbon dioxide was present as well as ethylene oxide. These differences in technique may well have combined to prevent the development of the high pH to which Hawk and Mickelsen attributed some of the injurious effects of ethylene oxide. In the liver brei that was treated with liquid ethylene oxide, there probably was a considerable buffering action, as well as some protective combinations of nitrilites not present in the rat diet.

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3. This diet was similar to that described by H. L. House [Can. J. Zool. 32, 331 (1954)] but with glucose reduced to 0.5 percent, salt mixture reduced to 0.33 percent, and KOH, rather than NaOH, used to adjust acidity.
4. This report is contribution No. 290, Chemistry Division, and No. 3346, Entomology Division, Science Service, Canada Department of Agriculture, Ottawa.

24 August 1955

Correction

The filter paper strips used in V. L. Johnson and J. S. Dunlap "Electrophoretic separation of hemoglobins from the chicken" [*Science* 122, 1186 (1955)] should be listed as follows: S. and S. No. 2043 B.

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3 January 1956

Book Reviews

Static and Dynamic Electron Optics. An account of focusing in lens, deflector, and accelerator. Cambridge Monograph on Mechanics and Applied Mathematics. P. A. Sturrock. Cambridge Univ. Press, London, 1955. x + 240 pp. \$5.50.

The range covered by this book is indicated more clearly by the subtitle "An account of focusing in lens, deflector, and accelerator." On the other hand, the subtitle should not mislead the reader into thinking that the book is concerned with devices. It is not. The emphasis is on the focusing. Furthermore, as the author makes plain in the preface, if not in the title, this is a theoretical treatise. Examples illustrating the theory are used sparingly.

In brief, the book is a treatise on geometric electron optics based, almost entirely, on the use of variational principles and the Hamiltonian characteristic functions in particular. The portion on static electron optics proceeds, after a brief introductory chapter, to a general treatment of path ensembles in the electric and magnetic field; imaging along curvilinear axes; the focusing properties of rotationally symmetric fields, including a derivation of third-order geometric, chromatic, and "relativistic" aberrations and the effect of space charge and asymmetries; and focusing in fields with mirror symmetry as encountered in deflection fields and particle spectrometers.

In the second part, on dynamic electron optics, time is introduced as an added variable in the characteristic function, and emphasis is placed on the "stability" of path ensembles—that is, the convergence or divergence of their envelopes. Its two chapters deal, respectively, with uniform focusing in particle accelerators, as illustrated by the original synchrotron and linear accelerator, and periodic focusing, exemplified by the strong-focusing synchrotron.

The scope of the book does not include the determination of focusing fields, focusing by electron mirrors, and the behavior of beams in fields in which there is a dynamical interplay between space charge and electrode potentials.

Even so, confining the information contained in it to 240 pages is a remark-

able accomplishment. It is made possible in part by making greater claims than usual on the reader's familiarity with theoretical mechanics and matrix and vector operations, in part by the practically complete avoidance of repetition. Finally, choices of units that eliminate constant coefficients simplify formulas and equations. This may well be worth while, even though it robs the reader of the comfort of dimensional checks and makes casual reference somewhat more difficult.

In summary, Sturrock's book is a unique and valuable contribution to the literature of electron optics. It is not an easy book to read. However, a careful perusal is likely to prove both stimulating and highly rewarding.

E. G. RAMBERG

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Vitamins and Hormones. vol. XIII. Robert S. Harris, G. F. Marrian, and Kenneth V. Thimann, Eds. Academic Press, New York, 1955. xi + 382 pp. \$9.

The marriage between the sciences of nutrition and endocrinology, arranged by the editors in 1943, in volume I of this series, continues to show no signs of strain or dissolution, like any good *mariage de convenance*. The present volume contains nine chapters by authors in four countries, five related to vitamins, two dealing with other nutritional topics, and two with hormones.

The eclecticism that results in the assembling of nine diverse surveys really means that within the covers of this volume one has nine small books—which would demand, at least, nine small reviews. But this, like small praise, would be damning, and the reader will understand if I settle for a brief run-through.

A. E. Axelrod and J. Pruzansky have set forth "The role of the vitamins in antibody production" and, by dissecting their analysis away from the thorny problems of resistance to infection, have succeeded in giving the subject a degree of definition that it has heretofore never possessed.

Harry J. Deuel, Jr., and Raymond

Reiser review the physiology and biochemistry of the essential fatty acids. This is straightforward and is in the nature of a progress report involving the application of the newer technology in lipid chemistry.

L. W. Mapson has totted up the present information on the biosynthesis of ascorbic acid, from D-glucose to the completely inverted L-ascorbate.

J. E. Ford and S. H. Hutner have pulled together the many diverse aspects of the role of vitamin B₁₂ in microorganisms, especially as tools in the penetration into the nest of the rapidly spawning multiplicity of pseudovitamin B₁₂ compounds.

Charles C. Ungley's thoughtful essay on the chemotherapeutic action of vitamin B₁₂ contains an interesting synopsis of the present knowledge of Castle's intrinsic factor and nails to the mast, once more, the dictum that, with the exception of the action of vitamin B_{12a} in cyanide poisoning, the only certain chemotherapeutic action of vitamin B₁₂ seems to be the correction of the metabolic disorder that results from an existing deficiency of the vitamin.

Lionel B. Pett, in a pithy piece, says some things about vitamin requirements of human beings that have needed saying. As Pett points out, we tend to ignore in these matters (i) biological variation, (ii) the phoniness of the view that consuming several multiples of demonstrable needs results in a kind of superhealth, and (iii) the undemonstrated basis of the view that to grow faster and larger is, *ipso facto*, an advantageous goal.

Dean A. Smith, in his view of parasitic infections and nutrition, is at his ease in dealing with the effect of the parasite on the nutrition of the host—which he finds is bad—but stumbles when he deals with the effects of host nutrition on the parasite and the disease it brings about.

W. S. Bullough concentrates on hormones and mitotic activity, but his contribution is overshadowed by the masterly essay of Oscar Hechter entitled "Concerning possible mechanisms of hormone action." Indeed, if the present volume has any claim to being memorable, it will be for its inclusion of this article by Hechter. Proceeding from an analysis of the operational bases of endocrinology, Hechter advances in the best scientific tradition to recover some important questions that have been lost in the modern mumble of answers. Like the best of philosophers, this author generates a certain disquietude and courageously, but modestly, stands against the stream of present preoccupation with energetics as suitable answers to all biological questions.

The widely accepted hormone-enzyme hypothesis here undergoes a searching cross-examination—and emerges scathed.

To this poverty of theoretical thought, Hechter brings some enriching gifts of his own and finally, having shown that the "old" pharmacologist's concern with cell membranes was not so naive after all, we are left with some hard-headed criteria against that day when we think we understand how a hormone "acts."

HOWARD A. SCHNEIDER

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Recent Progress in Hormone Research. vol. XI. Proceedings of the 1954 Laurentian Hormone Conference. Gregory Pincus, Ed. Academic Press, New York, 1955. 518 pp. Illus. \$10.

The Hormones. Physiology, chemistry and applications. vol. III. Gregory Pincus and Kenneth V. Thimann, Eds. Academic Press, New York, 1955. xiii + 1012 pp. Illus. \$22.

The ten previous volumes of *Progress in Hormone Research*, the proceedings of the Laurentian Hormone Conferences, provide the best interpretative record in existence of the progress of endocrinology during the decade in question. The new volume, XI, maintains the fine tradition of those that preceded it. In a more encyclopedic vein, volume III of *The Hormones* presents the combined efforts of a distinguished group of investigators, ranging from botanists to internists, to record the current status of studies of internal secretion in plants and invertebrate and vertebrate animals. They, too, have succeeded well.

I was introduced to endocrinology at a time when the pioneer teachers, such as W. W. Swingle, covered all important aspects of their subject in the lectures of one course. A glance at these two volumes shows that such feats are no longer possible. The field must now be subdivided into its own specialties, which in turn pervade almost all branches of biological science. Volumes like the two under consideration provide the indispensable reference tools through which some degree of unity and coordination can be achieved.

The Laurentian volume contains reviews of work on the following new substances by the investigators most directly involved: crystalline neurohypophyseal hormones (van Dyke *et al.*), amphenone (Hertz *et al.*), halogenated corticoids (Fried *et al.*), and aldosterone (Simpson and Tait). In addition, there are authoritative presentations on the regulation of ACTH secretion (Munson and Briggs), metabolism of anterior pituitary hormones (Sonenberg and Money), hormones and abnormal growth (Furth; Rawson and Rall), the relation of hor-

mones to aging (Engle; Pincus *et al.*), the mechanism of action of insulin (Levine and Goldstein), effects of ions and hormones on carbohydrate metabolism (Hastings *et al.*), and of humoral cardiovascular relationships (Stammeler *et al.*; Shorr *et al.*). The value of each paper is enhanced by the inclusion of extensive and well-edited discussions in which many new contributions are noted.

The Hormones is in the tradition of the German *Handbuchs* and includes comprehensive chapters, each with an extensive bibliography, on the following broad topics: plant growth hormones (Thimann and Leopold), invertebrate hormones (Scharer), neurohormones (Welsh), parathyroids (Greep and Kenny), insulin and glucagon (Stetten and Bloom), chemistry of the anterior pituitary hormones (Hays and Steelman), growth hormone and corticotrophin (Astwood), gonadotrophins and lactogen (Cowie and Folley), posterior pituitary (Landgrebe *et al.*), thyroid (Rawson *et al.*), steroid chemistry (Hirschmann), steroid metabolism (Dorfman), ovary and testis (Pincus), adrenal cortex (Noble), and clinical endocrinology (Paschke and Rakoff).

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Protein Malnutrition. Proceedings of a conference in Jamaica sponsored jointly by the Food and Agriculture Organization of the United States; World Health Organization; and Josiah Macy, Jr., Foundation, New York. J. C. Waterlow, Ed. University Press, Cambridge, England, 1955. xvi + 277 pp. Plates.

This monograph covers the proceedings of a conference on malnutrition held in Jamaica in 1953. The discussion is divided into the biochemical aspects, the pathology, the clinical aspects and treatment, and the epidemiology and prevention of protein malnutrition. The conference is carried on in the manner characteristic of the Macy conferences. The participants discuss the presentation freely. The reader becomes part of the conference and is exposed to the different points of view of the various members.

The biochemical aspects are presented by J. C. Waterlow of the University College of the West Indies in Jamaica. A good deal of his discussion is concerned with the clinical condition known as *kwashiorkor*, which occurs in children in certain parts of the world and is associated with liver damage. In considering the state of protein depletion, he points out that the degree of depletion, the pat-

tern of depletion, and its chronicity must be considered. The ultimate aim should be to find some means of assessing these three factors and studying how they interact in any given case.

The pathology of protein malnutrition is discussed by G. R. Bras of the University College of the West Indies in Jamaica. He describes venous occlusive disease (V.O.D.), a condition not seen in this part of the world. V.O.D. leads to severe pathological changes in the liver, sometimes indistinguishable from other infantile cirrhoses. It is frequently preceded by an acute infection, but it is always associated with malnutrition.

The clinical aspects and treatment of protein malnutrition are presented by M. V. R. Rao of the Haffkine Institute, Parel, Bombay, and are discussed in great detail by the group.

The epidemiology and prevention are presented by R. F. A. Dean of Uganda, East Africa. Discussion was aimed at the broad principles of prevention and treatment of malnutrition of children all over the globe. The question of the relation of the onset of the disease to the time of weaning was discussed at great length. It was obvious from the discussion that parasitic infestation and infection play a considerable part in the onset of the protein malnutrition diseases. Most of the members of the panel felt that it was important to derive protein from foods that could be grown locally.

This conference is excellent. The inter-
ruptions are sometimes a little disconcerting but always provocative. There is a tremendous amount of information in this monograph that will be of interest, not only to the individuals inhabiting the areas of the world where protein malnutrition in children has a high incidence, but also to those of us in this part of the world interested in the nutritional aspects of disease.

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Microscopy of Ceramics and Cements. Including glasses, slags, and foundry sands. Herbert Insley and Van Derck Fréchette. Academic Press, New York, 1955. xii + 286 pp. Illus. \$7.50.

This book brings together the extensive data on ceramics and inorganic cements and the fundamental knowledge and techniques necessary for their study. Although the book is devoted chiefly to light microscopy, electron microscopy is discussed in several connections.

The fundamentals of crystal optics are not treated at length. Indeed, these essential principles are stated so tersely that

supplemental materials will be needed in order to give satisfactory instruction in crystal optics to students in ceramic engineering. In contrast to this omission are the extensive applications that are discussed and the many helpful hints that are given on how to proceed—for example, those contained in Chapter 4, "Preparation of materials for microscopic examination." Here the authors describe a somewhat complicated gadget for selecting mineral grains under the microscope, but they do not mention the artist's brush moistened with saliva that has been used to select microfossils for many years. Separate chapters consider raw materials, whitewares, refractories, glass, cements, porcelain enamels, structural clay products, foundry sands, and slags. H. N. Baumann, Jr., contributed a chapter on abrasives.

An amusing inconsistency is the spelling of the plural of *alkali*. On page 71 it appears more than once as *alkalies*, whereas on page 88 and elsewhere, *alkalis* is used. The pronunciation of the latter spelling should rhyme with *kiss*, this, and *appendicitis*; it is objectionable. I was mildly surprised to learn that my former colleagues and I (p. 196) do not adhere to the osmotic theory for expansion of concrete during alkali-aggregate reaction. Comparisons of our calculated and measured pressures were offered by us as evidence that osmosis is involved. The spelling of *forsterite* is in error on page 146, under Fig. 8.17, and *pseudowollastonite* is hyphenated in about half of its appearances. Despite other trivial defects, the arrangement and presentation are excellent.

Mineralogists and petrographers will find this book extremely useful in connection with the examination of raw materials and fired products. Persons engaged in research or development of ceramic materials will find it invaluable.

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New Books

Handbook of Vital Statistics Methods. Ser. F, No. 7, *Studies in Methods*. Statistical Office of the United Nations, New York, 1955. 258 pp. \$2.50.

Nuclear Magnetic Resonance. E. R. Andrew. Cambridge Univ. Press, New York, 1955. 265 pp. \$6.50.

An Introduction to Botany. Arthur W. Haupt. McGraw-Hill, New York, ed. 3, 1956. 447 pp. \$5.50.

Science and Modern Life. E. John Russell. Philosophical Library, New York, 1955. 101 pp. \$2.75.

Principles of Physical Metallurgy. Morton C. Smith. Harper, New York, 1956. 417 pp. \$6.

Advances in Food Research. vol. VI. E. M. Mrak and G. F. Stewart, Eds. Academic Press, New York, 1955. 397 pp. \$9.

The Role of Algae and Plankton in Medicine. Morton Schwimmer and David Schwimmer. Grune & Stratton, New York-London, 1955. 85 pp. \$3.75.

Relativity: The Special Theory. J. L. Synge. North-Holland, Amsterdam; Interscience, New York, 1956. 450 pp. \$10.50.

Plane Waves and Spherical Means Applied to Partial Differential Equations. Interscience, New York-London, 1955. 172 pp. \$4.50.

Chemical Pilot Plant Practice. Donald G. Jordan. Interscience, New York-London, 1955. 152 pp. \$3.50.

The New Astronomy. 243 pp. *Automatic Control*. 148 pp. *Atomic Power*. 180 pp. *The Physics and Chemistry of Life*. 270 pp. *First Book of Animals*. 240 pp. Editors of *Scientific American*. Simon and Schuster, New York (reprinted from *Scientific American*), 1956. Paper, \$1 each.

Soil Physics. L. D. Baver. Wiley, New York; Chapman & Hall, London, ed. 3, 1956. 489 pp. \$7.75.

Index to the Year Books and Regional Papers of the American Iron and Steel Institute. Compiled by Jeanne McHugh. Univ. of Oklahoma Press, Norman, 1955. 593 pp. \$12.50.

Philosophical Writings of Peirce. Justus Buchler, Ed. Dover, New York 10 (unaltered and unabridged republication of *The Philosophy of Peirce: Selected Writings*, Routledge and Kegan Paul, 1940), 1955. 388 pp. Cloth, \$4.50; paper, \$1.95.

Ludwig Boltzmann, *Mensch, Physiker, Philosoph*. Engelbert Broda. Deuticke, Vienna, 1955. 152 pp.

Judaism and Psychiatry. Two approaches to the personal problems and needs of modern man. Simon Noveck, Ed. National Acad. for Adult Jewish Studies, United Synagogue of America, New York, 1956. 197 pp. Paper, \$2.50.

Vascular Surgery in World War II. Daniel C. Elkin and Michael E. DeBaakey, Eds. Historical Unit, Army Medical Service, Washington, 1955 (Order from Supt. of Documents, GPO, Washington 25). 465 pp. \$4.25.

The Sun and Its Influence. An introduction to the study of solar-terrestrial relations. M. A. Ellison. Macmillan, New York, 1956. 235 pp. \$4.50.

The Blood-Brain Barrier with Special Regard to the Use of Radioactive Isotopes. Louis Bakay. Thomas, Springfield, Ill., 1956. 154 pp. \$5.50.

The Dynamics of Living Protoplasm. L. V. Heilbrunn. Academic Press, New York, 1956. 327 pp. \$6.50.

Principles of Organic Chemistry. An introductory text in organic chemistry. James English, Jr., and Harold G. Cassidy. McGraw-Hill, New York, ed. 2, 1956. 469 pp. \$6.50.

Distillation in Practice. A collection of papers originally presented in Philadelphia, Pa., in May, 1954, under the auspices of the Philadelphia-Wilmington Section of the American Institute of Chemical Engineers and the Department of Chemical Engineering, University of Pennsylvania. Charles H. Nielsen, Ed. Reinhold, New York; Chapman & Hall, London, 1956.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, but to the publisher or agency sponsoring the publication.)

National Society of Professional Engineers, Annual Report, 1954-1955. A report to the membership. The Society, Washington, 1955. 24 pp.

Bulletin Climatologique Annuel du Congo Belge et du Ruanda-Urundi Année 1954. Bureau Climatologique, Communication No. 10. Institut National pour l'Etude Agronomique du Congo Belge, Bruxelles, 1955. 161 pp. F. 120.

Abatement of Highway Noise and Fumes. Highway Research Bd. Bull. 110. National Acad. of Sciences-National Research Council, Washington, 1955. 47 pp. \$0.90.

Rubber Rolls. Rodney Hunt Machine Co., Orange, Mass., 1955. 59 pp. \$2.

Some Conditions Affecting Quality, Consistency, and Predictability of Performance in Solving Complex Problems. Research Rept. AFPTRC-TN-55-27. Project No. 7703, Task Nos. 77071 and 77973. Robert M. W. Travers, Joseph E. Marron, and Andrew J. Post. 86 pp. *Some Correlates of Instructor Job Satisfaction*. Research Rept. AFPTRC-TN-55-28. Project No. 7731, Task No. 77427. John T. Lanzetta and Dorothy M. Knoell. 49 pp. Air Force Personnel & Training Research Center, Lackland Air Force Base, San Antonio, Tex., 1955.

Spectrochemical Abstracts, 1946-1951. vol. IV. Ernest H. S. van Someren and F. Lachman. Hilger & Watts, London, 1955. 179 pp. \$5.75.

Life History and Cytology of the Foraminiferan Allogromia Laticollaris. Publ. in Zoology, vol. 61, No. 4. Zach M. Arnold. 86 pp. \$1.25. *Planned Migration, the Social Determinants of the Dutch-Canadian Movement*. Publ. in Sociology and Social Institutions, vol. 2. William Petersen. 273 pp. \$3.50. Univ. of California Press, Berkeley, 1955.

A Study of African Chironomidae. pt. 1. Bull. of the British Museum (Natural History) Entomology, vol. 4, No. 1. Paul Freeman. 68 pp. 15s. *The Heterophyllous Selaginellae of Continental North America*. Bull., Botany, vol. 1, No. 8. A. H. G. Alston. 55 p. 16s. *Mosses of Dominica, British West Indies and Mosses of the Ecuadorian Andes Collected by P. R. Bell*. Bull., Botany, vol. 2, No. 2. Edwin B. Bartram. 30 pp. 6s. British Museum (Natural History), London, 1955.

New York University, College of Engineering, Research Division Annual Report, 1955. New York Univ., New York, 1955. 36 pp.

Education Directory. pt. 4, *Education Associations, 1954-55*. 56 pp. \$0.25. *Clerical and Custodial Staff in Public Secondary Day Schools*. Circular No. 445. Ellsworth Tompkins and Mabel C. Rice. 83 pp. \$0.55. U.S. Office of Education, Washington 25, 1955 (Order from Superintendent of Documents, GPO, Washington 25).

Control of Insect Vectors in International Air Traffic. A survey of existing legislation. World Health Organization, Geneva, 1955. 59 pp. \$0.70.

Scientific Meetings

Mutation

The Brookhaven Symposium on Mutation, held at the Brookhaven National Laboratory in June 1955, attracted 335 participants apart from laboratory staff and included scientists from 17 countries in addition to the United States. A high level of interest, manifested by lively discussion following each of the 16 papers presented, was sustained over the 3-day period of the symposium. Such interest is a tribute to the continuing fertility of an area of genetics that has been vigorously exploited at least since 1927, when H. J. Muller reported the successful induction of mutations by x-irradiation. Fittingly, Muller delivered a major address to the symposium, conveying at once a sense of the significance of the mutation field in biology, of the refinement of technique that has gone into its study, and of the multiplicity of results that have been obtained. A few generalities emerging from the symposium seem noteworthy here.

S. Benzer presented evidence that certain of the recombination units in bacteriophage may be no larger than approximately a dozen nucleotide pairs. Whether the "recombination" that delineates these units in phage is the same process that has permitted the establishment of the classical chromosome maps is not clear. In any event, the observations are highly suggestive in relation to Benzer's finding that mutations may involve various "lengths" of the linearly arranged genetic material of phage and open the way to refined analysis of the functional and spatial organization of this genetic material.

The contribution of M. and Z. Deme-rec based on studies of transduction in *Salmonella* appears to have the same general implications as Benzer's work. In addition it gives examples of linearly arranged genetic units whose spatial sequence corresponds to functional sequences, functions being defined by various steps in a chain of biochemical reactions controlled by these units. That mutation frequencies themselves may be utilized in the precise definition and analysis of genetic material was reemphasized by N. H. Giles, who has focussed attention on forward and back mutation at particular loci, including

apparent pseudoallelic clusters, in *Neurospora*. Work reported by W. L. Russell indicates that even such a relatively difficult genetic object as the mouse may be subjected to meaningful scrutiny in much the same way.

The studies mentioned in the preceding paragraphs relate fundamentally to the organization of genetic material in cells and have to do with the conceptual basis of genetics. From the time of Mendel, genetics has been one of the particulate sciences, and the characteristic methods of genetics have been the methods of a particulate science. The particles dealt with by the geneticist, at least on the main track of his science to the present, are genes linearly arranged in chromosomal material. Although present information, as represented in several of the symposium papers, in no way denies a particulate or discontinuous nature of hereditary materials, genetic particles as delineated variously by mutation, by chemical function, or by recombination are no longer readily seen as being unitary. If mutation studies were of interest for no other reason, they would at least be of enormous importance in elucidating the basic structure of the germ plasm.

An important fraction of the papers at the symposium dealt with various conditions that affect mutation frequency. The number and variety of conditions known to be effective in this way is impressively large already, and the possibilities have only begun to be sampled. Indicating the scope of present knowledge were reports on the oxygen effect on mutation, on the antimutagenic action of certain pyrimidine and purine ribosides, and on the correlation of differences in mutation frequency with differences in sex. In addition, W. S. Stone summarized the now well-known observations that ultraviolet light induces mutations in bacteria, not only when it is directed against cells themselves, but also when it is directed against media into which cells are later inoculated. Even though these observations seem best interpreted on the basis that the effect of ultraviolet light on medium is to produce chemical mutagens, which act upon the bacteria, these observations also reinforce the growing concept that the physiological state of the organism is

highly important for the mutation process. It is possible that simple models for the direct action of mutagens on genetic material are inadequate and that the repair processes involving disrupted genetic material have a biological significance that has scarcely been realized. In an age when human populations have been exposed to increasing dosages of mutagens, and when both the dosages and the numbers of individuals involved may become still larger, the mechanism of induction of mutation and the factors that affect it become matters of vital importance.

It is worthy of brief comment that slightly more than half the papers given at the symposium were based on work falling within the broad area of microbial genetics. Doubtless a primary reason for this emphasis is that many kinds of mutations, even when elicited as effectively as possible by an inducing agent, are rare events. Techniques developed with microorganisms have enabled the screening of huge populations for the appearance of mutations. No less attractive, experimentally, are the readier avenues to chemical description of mutational processes, especially in the viruses. Nevertheless, the more classical organisms of genetics, notably *Drosophila* and maize, will continue to provide much fundamental information about mutation and the nature of genes. The precise identification and control of genetic units, largely referable to some decades of careful chromosome mapping in *Drosophila* and maize, and to the detailed cytological study of these favorable objects, permit an elegance of technique of certain kinds that is still far from possible in the best known of microorganisms. Many examples emerged in Muller's analysis of the relationship between chromosome changes and gene mutations. The advantages of closely cataloged germ plasm were particularly apparent in B. McClintock's demonstration of activator, dissociator, and modulator systems in maize, a demonstration that appears to discriminate between mutability and the perhaps equally important phenomenon of intranuclear control of gene action by mechanisms other than mutation.

No critical evaluation of the various papers, or even brief summaries or mention of all of them, is possible here. The symposium papers themselves and transcriptions of their formal discussion are being published by Brookhaven National Laboratory as *Brookhaven Symposia in Biology*, volume 8. The volume will contain about 250 pages and will be obtainable at a cost of \$1.25 from the Office of Technical Services, Department of Commerce, Washington, D.C., after 1 Feb. 1956.

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Meeting Notes

■ The 15th annual Frontiers in Chemistry lectures, an activity of the department of chemistry of Western Reserve University, will present ten leading scientists on consecutive Fridays from 17 Feb. through 20 Apr. There are two major topics, "Application of instruments to analysis and molecular structure" and "Chemistry of organometallic and chelate compounds."

For each topic there are five lecturers. They are P. Debye of Cornell University, Robert W. Parry of the University of Michigan, P. W. Selwood of Northwestern University, A. H. Corwin of Johns Hopkins University, H. S. Gutowsky of the University of Illinois, A. E. Martell of Clark University, Paul Delahay of Louisiana State University, Avery A. Morton of Massachusetts Institute of Technology, Walter Gordy of Duke University, and John C. Bailar, Jr., of the University of Illinois.

■ The American Association of Spectrographers is planning its seventh annual conference in Chicago, Ill., 4 May, on the subject "New developments and techniques in spectroscopy." Contributed papers in the fields of emission, x-ray fluorescence, or absorption spectroscopy are invited. Abstracts must be submitted by 16 Mar. Address all inquiries to John P. Merutka, H. M. Harper Company, 8200 Lehigh Ave., Morton Grove, Ill.

■ The 16th annual general meeting of the Indian Society of Genetics and Plant Breeding was held at New Delhi on 12 Dec. 1955 under the presidency of T. R. Mehta, joint director of research, Madhya Bharat College of Agriculture and Research Institute, Gwalior. Mehta delivered an address entitled "The genotype in agriculture." The society decided to organize a symposium during 1956 on "The role of genetics in the improvement of tropical crop plants"; a subcommittee under the chairmanship of B. P. Pal was appointed for this purpose.

■ The following visitors from abroad were among those who participated in the International Conference on Fatigue in Aircraft Structures, which was held at Columbia University 30 Jan.-1 Feb.

England: P. J. E. Forsyth and R. J. Atkinson of the Royal Aircraft Establishment, Farnborough; N. Thompson of the H. H. Wills Physical Laboratory, Bristol; R. F. Hanstock of High Duty Alloys, Ltd., Slough; H. Giddings of the Bristol Aeroplane Co., Ltd., Bristol.

Scotland: G. E. Phillips of the Mechanical Engineering Research Laboratory, East Kilbride.

Australia: W. A. Wood of the metal research department, University of Melbourne.

Germany: M. Hempel of the Max Planck Institute for Steel Research, Düsseldorf; E. Gassner, Laboratory for Performance Testing, Darmstadt.

Sweden: W. Weibull of Stockholm; Bo Lundberg of the Aeronautical Research Institute of Sweden, Stockholm; F. Turner of SAAB Aircraft Co., Linköping.

The conference was jointly sponsored by Columbia University's Department of Civil Engineering and Engineering Mechanics, its Institute of Flight Structures, and the Office of Scientific Research and Development of the U.S. Air Force. Alfred M. Freudenthal, professor of civil engineering at Columbia, was chairman of the organizing committee for the meeting.

■ The American Association of Physical Anthropologists will celebrate its 25th anniversary when it meets at the University of Chicago 6-8 Apr. In addition to the anniversary celebration, which will be held during the annual dinner, special features include a symposium on "Early man in Africa," organized by Sherwood L. Washburn, and a panel discussion on problems in human identification that will be led by Russell Newman.

■ A European Symposium on Vitamin B₁₂ and Intrinsic Factor will take place under the sponsorship of Prof. J. Kuhnau, Physiologisch Chemisches Institut der Universität Hamburg (Germany), 23-26 May. For further information, address the secretary of the symposium, Dr. H. C. Heinrich.

■ The Primer Congreso Panamericano de Gerontología will be held in Mexico, D.F., under the presidency of Manuel Payno, 7-15 Sept. Payno is the president of the Academia Mexicana de Gerontología and the Sociedad Mexicana de Geriatria. His address is Ave. Cuauhtemoc No. 10-3, Mexico 7, D.F. J. H. Sheldon, president of the International Association of Gerontology, has agreed to serve as an honorary president.

Those desiring to present papers should send abstracts of not more than 200 words to E. V. Cowdry, Washington University School of Medicine, St. Louis 10, Mo., before 1 Apr. Please mention whether or not lantern slides are to be shown.

Society Elections

■ Indian Society of Genetics and Plant Breeding: pres., V. M. Chavan, Poona; sec., M. S. Swaminathan, New Delhi; treas., N. L. Dhawan, Division of Botany, Indian Agricultural Research Institute, New Delhi. The vice presidents are P. N. Bhaduri, New Delhi, and G. S. Murty, New Delhi.

■ International Institute of Embryology: pres., M. W. Woerdeman; sec.-treas., Chr. P. Raven. The vice presidents are E. Fauré-Fremiet, F. E. Lehmann, and Paul Weiss.

■ American Eugenics Society: pres., Harry L. Shapiro; v. pres., Alan F. Guttmacher; sec., Frederick Osborn, AES, 230 Park Ave., New York 17; treas., Chauncey Belknap.

■ National Association of Biology Teachers: pres., John P. Harrold, 110 E. Hines St., Midland, Mich.; pres.-elect, John Breukelman, State Teachers College, Emporia, Kan.; past pres., Brother Charles, St. Mary's College, Winona, Minn.; sec.-treas., Paul V. Webster, Bryan City Schools, Bryan, Ohio. The vice presidents are Irene Hollenbeck, Howard E. Weaver, and Robert L. Smith.

■ European Organization for Nuclear Research (CERN): pres., Sir Ben Lockspeiser (United Kingdom); v. presidents, M. Jacques de Bourbon-Busset (France) and Prof. Ivar Waller (Sweden); chairman of the Finance Committee, M. Jean Willems (Belgium); additional members of the Committee of Council, Dr. Antonio Pennetta (Italy) and Prof. Paul Scherrer (Switzerland).

■ Western Society of Naturalists: pres., Albert Tyler, California Institute of Technology; v. pres., William M. Hiesey, Carnegie Institution of Washington, Division of Plant Pathology, Stanford, Calif.; sec., Demorest Davenport, Santa Barbara College, University of California; treas., Marion Ownbey Washington State College.

■ American Society for the Study of Arteriosclerosis: pres., Arthur C. Corcoran, Cleveland Clinic, Cleveland, Ohio; past pres., L. N. Katz; v. pres., Charles F. Wilkinson, Jr., New York; sec.-treas., O. J. Pollak, P.O. Box 228, Dover, Del.

Forthcoming Events

March

8. Assoc. of Vitamin Chemists, Chicago, Ill. (M. Freed, Dawes Products, 4800 S. Richmond, Chicago 32, Ill.)

9-10. Midwest Conf. on Theoretical Physics, Iowa City, Iowa. (J. M. Jauch, Dept. of Physics, State Univ. of Iowa, Iowa City.)

12-16. National Assoc. of Corrosion Engineers, 12th annual, New York, N. Y. (Secretary, NACE, Southern Standard Bldg., Houston 2, Tex.)

14-17. National Science Teachers Assoc., Washington, D.C. (R. H. Carleton, NSTA, 1201 16 St., NW, Washington 6.)

15-16. Food Physics Symposium, 1st

international, San Antonio, Tex. (C. W. Smith, Southwest Research Inst., San Antonio.)

15-17. American Orthopsychiatric Assoc., 33rd annual, New York, N.Y. (M. F. Langer, AOA, 1790 Broadway, New York 19.)

15-17. American Physical Soc., Pittsburgh, Pa. (K. K. Darrow, APS, Columbia Univ., New York 27.)

15-17. Kappa Delta Pi, annual, Stillwater, Okla. (E. I. F. Williams, 238 E. Perry St., Tiffin, Ohio.)

16-18. International Assoc. for Dental Research, St. Louis, Mo. (D. Y. Burrill, 129 E. Broadway, Louisville 2, Ky.)

17-18. National Soc. of Professional Engineers, annual spring, Washington, D.C. (K. E. Trombley, NSPE, 1121 15 St., NW, Washington 5.)

18-24. American Soc. of Photogrammetry, annual, joint meeting with American Cong. on Surveying and Mapping, Washington, D.C. (ACSM-ASP, Box 470, Washington 4.)

19-21. Div. of Fluid Dynamics, American Physical Soc., Pasadena, Calif. (F. N. Frenkiel, Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.)

19-22. American Acad. of General Practice Scientific Assembly, 8th annual, Washington, D.C. (AAGP, Broadway at 34th, Kansas City 11, Mo.)

19-22. Inst. of Radio Engineers National Convention, New York. (E. K. Gammett, IRE, 1 E. 79 St., New York 21.)

19-23. American Soc. of Tool Engineers, Chicago, Ill. (H. C. Miller, Armour Research Foundation, 35 W. 33 St., Chicago 16.)

21-22. National Health Forum, New York, N.Y. (T. G. Klumpp, National Health Council, 1790 Broadway, New York 19.)

21-23. American Power Conf., 18th annual, Chicago, Ill. (R. A. Budenholzer, Illinois Institute of Technology, Chicago 16.)

21-24. American Astronomical Soc. Columbus, Ohio. (J. A. Hynek, McMillin Observatory, Ohio State Univ., Columbus.)

22-24. Michigan Acad. of Science, Arts and Letters, annual, Ann Arbor. (G. M. McEwen, 5 East Hall, Univ. of Michigan, Ann Arbor.)

23-24. Eastern Psychological Assoc., Atlantic City, N.J. (G. G. Lane, Univ. of Delaware, Newark.)

23-24. North Carolina Acad. of Science, annual, Chapel Hill. (J. A. Yarbrough, Meredith College, Raleigh.)

24-25. American Psychosomatic Soc., 13th annual, Boston, Mass. (T. Lidz, APS, 551 Madison Ave., New York 22.)

24-31. Perspectives in Marine Biology, La Jolla, Calif. (A. A. Buzzati-Traverso, Scripps Institution of Oceanography, La Jolla.)

25-28. American Assoc. of Dental Schools, annual, St. Louis, Mo. (M. W. McCrea, 42 S. Greene St., Baltimore 1, Md.)

25-29. American College Personnel Assoc., Washington, D.C. (Mia C. M. Northrup, Univ. of Denver, Denver, Colo.)

28-3. Colloquium on Frontiers in Physical Optics, Boston, Mass. (S. S. Ballard, Visibility Laboratory, Scripps Institution of Oceanography, San Diego 52, Calif.)

29-31. Pennsylvania Acad. of Science, Indiana. (K. Dearolf, Public Museum and Art Gallery, Reading, Pa.)

29-31. Southern Soc. for Philosophy and Psychology, Asheville, N.C. (J. E. Moore, Georgia Inst. of Technology, Atlanta.)

29-31. Symposium on Fundamental Cancer Research, 10th annual, Houston, Tex. (G. Taylor, Univ. of Texas Postgraduate School of Medicine, Houston 25.)

30-31. Alabama Acad. of Science, annual, Montevallo. (H. A. McCullough, Howard College, Birmingham, Ala.)

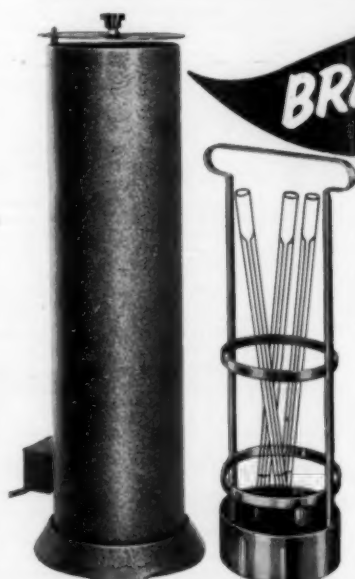
April

2-5. Assoc. of American Geographers, annual, Montreal, Canada. (B. W. Adkins, Library of Congress, Washington 25.)

2-7. Symposium on Crystallography, Madrid, Spain. (M. Abbad, Serrano 118, Madrid.)

3. Microcirculatory Conf., 3rd, Milwaukee, Wis. (G. P. Fulton, Dept. of Biology, Boston Univ., 675 Commonwealth Ave., Boston 15, Mass.)

(See issue of 20 January for comprehensive list)



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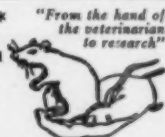
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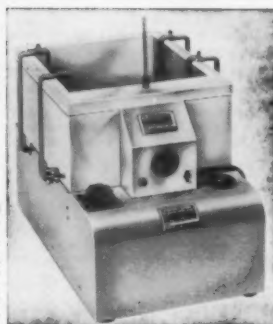
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Sex in Microorganisms

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The genetic, physiological, and morphological evidence for "sex" in the principal groups of microorganisms—viruses, bacteria, fungi, unicellular algae, and protozoa—is presented by a group of experts in the field.

N. Visconti of the Carnegie Institution of Washington at Cold Spring Harbor, discusses recombination of "genes" in viruses. J. Lederberg of Wisconsin and E. L. Tatum of Stanford review genetic evidence for "sex" in bacteria, and W. G. Hutchinson of Pennsylvania and H. Stempen of Jefferson Medical College describe cell fusions in certain bacteria. J. R. Raper offers a comprehensive coverage of sex in fungi.

R. Patrick of the Academy of Natural Sciences, Phila-

delphia, describes syngamy in diatoms; R. A. Lewin of the Maritime Regional Laboratory, Halifax, the sexuality of other unicellular algae, especially the flagellates.

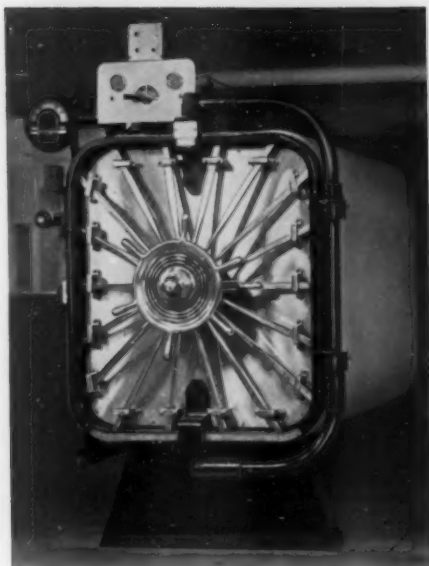
In two chapters D. H. Wenrich covers sexual phenomena in some of the protozoa and discusses the origin and evolution of sex, based primarily on the protozoa, but including material about all of the microorganisms. D. L. Nanney of Michigan summarizes mating-type phenomena in *Paramecium aurelia* and some of the recent mating-type work from Sonneborn's laboratory. C. B. Metz of Florida State compares mating-type substances in *Paramecium* and other ciliates with those found in Metazoa. Extensive chapter bibliographies are included.

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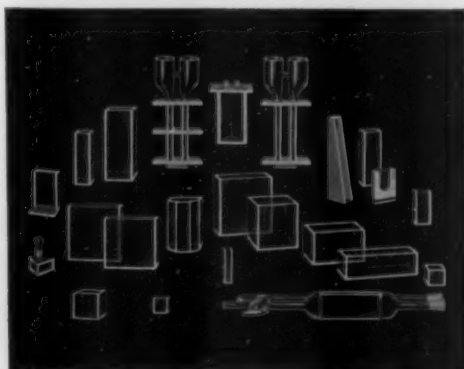
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